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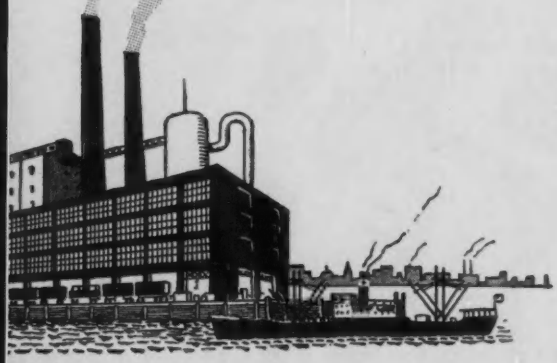

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THE FUTURE

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ECONOMIC GEOGRAPHY

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A METHOD FOR MEASURING CHANGE IN THE DISTRIBUTION OF MANUFACTURING ACTIVITY: THE UNITED STATES, 1939–1947

Wilbur Zelinsky

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FEW topics in the field of economic geography have aroused as much interest, not only among geographers and economists but among the general public as well, as has the question of recent locational shifts in the manufacturing industries of the United States. Although there has been progress in defining the terms of the problem and in describing some general tendencies in the spatial distribution of American industry, many aspects of the subject remain unexplored, and some important questions have been, at best, only partially solved.[1] What is more disturbing is the fact that the basic techniques for the measurement of spatial distribution and its dynamics for any set of geographic phenomena have not as yet been adequately developed.[2] In devising a method for a more nearly definitive description of recent shifts in American manufacturing, it is hoped that one such technique has been arrived at, one which can be applied to similar problems in economic and population geography where variable phenomena are dealt with quantitatively.

AN INDEX TO MANUFACTURING ACTIVITY

The problem at hand may be divided into several phases: namely, the definition of manufacturing activity and the choice of proper indices for its measurement; the selection of sources of data; the demarcation of meaningful subnational areal units among which locational shifts are to be observed; the derivation of a statistical—and cartographic—method whereby areal shifts in the designated index can be traced; and, finally, if we are to avoid much of the confusion that has bedeviled this

[1] The earlier literature on the subject is listed in Douglas Moore McDonald: *A Select Bibliography on the Location of Industry*, McGill University, Montreal, 1937; the more recent material is covered in Chauncy D. Harris: *A Bibliography of the Geography of Manufacturing*, Department of Geography, University of Chicago, Chicago, 1952. For a concise review of the current status of research on industrial geography in the United States, see Chauncy D. Harris: "The Geography of Manufacturing," Chapter 12, pp. 292–308, in *American Geography: Inventory and Prospect*, Syracuse, 1954.

[2] The most significant effort along these lines has been John K. Wright: "Some Measures of Distribution," *Annals Assn. Amer. Geogrs.*, Vol. 27, 1937, pp. 177–211, but few geographers have elected to follow Dr. Wright's example.

subject, the adoption of a rigorous terminology for describing the various types of locational change to be encountered.

The initial step of deciding on an acceptable index for manufacturing activity is more complex than might appear to the casual onlooker.[3] This is so because of the number of such indices theoretically available, the necessity for adopting the means best suited to the specific purposes of a study, and, most of all, the peculiar difficulty of measuring adequately a phenomenon in which technological change in processing, the number and varying quality of products, and the relationships between plant operatives and products have been in such rapid flux. Although the industrial geographer has no alternative but to adopt the Census Bureau's general definition of manufacturing, it must be noted that the official inclusion or exclusion of certain marginal activities or establishments of a certain size or institutional status can be argued. The fact that periodic changes occur in this definition, dictated largely by the swiftly changing facts of American economic life, is a complication that can be neither ignored nor circumvented. We leave in abeyance the wholly legitimate question of how realistic it is to thrust together scores of disparate economic pursuits under the rubric of aggregate manufacturing activity. In certain types of studies it is advantageous to isolate the individual industries or groups thereof, each of which observes its own quasi-autonomous code of economic behavior. Yet there is enough general agreement as to the distinctiveness of manufacturing industries as a class from other categories of economic activity so that this rather motley assemblage can be dealt with profitably as a whole, as is done here. Parenthetically, it may be noted that much of the methodology developed here can be applied to individual industries, as well as to the sum of all.

Items which have appeared at one time or another in Census reports and other sources and have been nominated as appropriate indices for manufacturing activity include: (1) number of establishments, (2) wages and salaries, (3) value of materials consumed, (4) installed horsepower of prime movers, (5) energy consumption, (6) plant floor space, (7) capital investment, (8) physical product, (9) gross value of product, (10) value added by manufacture, (11) total number of employees, and (12) number of production workers. The field is considerably narrowed by the fact that the first seven of these must generally be rejected out of hand, either because data are lacking for the specific years or political subdivisions required or because they have been adjudged seriously defective by most scholars who have surveyed the problem critically. At first glance, it might seem that the ideal method for reckoning industrial output is simply in terms of the physical product, e.g., barrels of oil, yards of cloth, cases of canned goods, etc. In actual practice, of course, insuperable obstacles interpose themselves: few industries have remained so static that their products are readily comparable from one enumeration to the next; different grades, varieties, and

[3] This problem has been discussed critically by a number of writers, among them Edmund E. Day and Woodlief Thomas: *The Growth of Manufactures, 1899 to 1923*, Bureau of the Census, Census Monographs, Vol. VIII, Washington, 1928, pp. 15–31; H. H. McCarty: *Industrial Migration in the United States, 1914–1927*, Iowa Studies in Business, Vol. 7, 1930, pp. 11–15; Alfred J. Wright: "Manufacturing Districts of the United States," *Econ. Geogr.*, Vol. 14, 1938, pp. 195–200; and P. S. Florence, W. G. Fritz, and R. C. Gibbs: "Measures of Industrial Distribution," Chapter 5 in National Resources Planning Board, *Industrial Location and National Resources*, Washington, 1943.

sizes of products within a given industry are seldom statistically convertible into one another; the task of adding together the products of different industries presents almost superhuman complications; while the last and perhaps most fatal objection is the fact that a given item is frequently reported by two or more processors in its course from raw materials to consumer, and such duplication in counting is self-defeating for the student of areal differences in manufacturing.[4] Some of these objections can be met by translating physical product into gross cash value; but there still remains the problem of multiple reporting of value and the fact that the cost of raw materials—an irrelevant factor—is not subtracted from that of the product. Consequently, this index is rarely utilized in studies of temporal or spatial shifts in manufacturing.

The present writer subscribes to the opinion that the most meaningful indication of the economic product of the manufacturing process is value added by manufacture, a criterion which neatly eliminates both the cost of materials and the problem of multiple reporting.[5] On the other hand, many scholars have selected number of employees as the index best suited to their purposes. Even though this choice was frequently dictated by the immediate objectives of the study in question or the relative ease of handling the data, it is clear that this index, which often yields results diverging considerably from those obtained from value added, cannot be summarily dismissed. If the complex entity we term manufacturing is to be studied in the round, then we must acknowledge its social as well as its purely economic phases, so that an adequate index to manufacturing activity must necessarily be plural. In the present instance, the discussion is essentially confined to the two items of value added and number of employees because problems in mensuration encountered in this exploratory study demand that the statistical elements be kept down to a manageable number. The choice between total number of employees and those classified as production workers is a matter of the logic of the study in question; but in the present, broadly theoretical paper, the latter are preferred inasmuch as the location of nonproduction employees is, for many firms, imperfectly correlated with that of plant operatives.

In using a combination of value added by manufacture and number of production workers, it appears desirable to note the functional relationship between these two factors, namely, value added = production workers X per-worker productivity, especially since the final term, output per worker, does not always vary in the same direction or to the same extent as the others, being subject to rather different influences.

A final, but highly crucial problem is the relationship between industrial activity, however gauged, on the one hand, and total population on the other. Although previous studies have not fully recognized the importance of this relationship,[6] it is evident that the

[4] A valiant attempt to gauge the dynamics of manufacturing in terms of physical product is Day and Thomas, *op. cit.*, in which the method is applied nationally to major categories of manufacturing. In treating "the growth of industry by geographic division and state" (pp. 79–89), however, the authors are forced to resort to other indices.

[5] For best results it is necessary to make allowances for changes in the value of money during the study period, as has been done for the 1939–1947 interval in John H. Thompson, "A New Method for Measuring Manufacturing," *Annals Assn. Amer. Geogrs.*, Vol. 45, 1955, pp. 416–436.

[6] The most important exception to this statement is to be found in Thompson, *op. cit.* There is a partial recognition of the relevance of population change to industrial change in Coleman Woodbury, ed., *The Future of Cities and Urban Redevelopment*, Chicago, 1953, p. 144 ff.; Evelyn

(*Continued on next page*)

locational history of consumers and workers has played a major role in localizing manufactures and, conversely, the uneven distribution of industry has generated much migration and differential population growth. On the axiom that industrial activity is meaningless in a universe without people, two additional items were added to our indices, the full roster of which now reads:

1. absolute value added by manufacture;
2. number of production workers;
3. per-worker value added by manufacture;
4. per-capita value added by manufacture; and
5. production workers as a percentage of total population.

SOURCES OF DATA

The selection of the above factors effectively eliminates all but one source of data. The Census of Manufactures, which has been conducted by the Bureau of the Census 26 times between 1809 and 1954, has provided the information essential for the computation of these indices since 1849; and during the recent past has published data for counties and various types of metropolitan areas for 1899, 1919, 1929, 1939, 1947, and 1954.[7] It may be noted in passing that since 1930 the Population Census has included among the items tabulated by county a breakdown of population by major occupational groups, including employment in manufacturing. Among the drawbacks to the use of this material are the brevity of the period covered, certain shifts in occupational definitions, the enumeration of employees by place of residence rather than by place of work, a failure to distinguish between production and non-production employees, and the absence of other data applicable to manufacturing. In partial compensation, the concurrent enumeration of total population and manufacturing employment obviates the need for estimating population figures. Another alternative is the joint annual publication by the Bureau of the Census and the Department of Health, Education, and Welfare of data on number of manufacturing establishments and their employees by county and a wider variety of data by state, drawing on material from the Bureau of Old Age and Survivors Insurance files and a yearly mail sampling of manufacturers.[8] Although these series offer special resources applicable to certain types of distributional studies, the present paper is limited to material drawn from the Census of Manufactures.[9] Since this study was well advanced before even the preliminary results of the 1954 enumeration had been released, its data are taken from the 1939 and 1947 censuses, the most recent

M. Kitagawa and Donald J. Bogue: *Suburbanization of Manufacturing Activity within Standard Metropolitan Areas*, Scripps Foundation for Research in Population Problems and Population Research and Training Center, University of Chicago, Studies in Population Distribution, No. 9, Oxford, Ohio, 1955, pp. 11–13; and Marion Hayes: "Regional Shifts in Industry and Population, 1899–1949," *Monthly Labor Review*, Vol. 71, 1950, pp. 106–108.

[7] Most of the essential bibliographic detail for this series is furnished in U. S. Department of Commerce and Library of Congress, *Catalog of United States Census Publications, 1790–1945*, Washington, 1950. Post-1945 publications are listed in the annual and semi-annual supplements to this catalog.

[8] The most recent issues are U. S. Department of Commerce and Department of Health, Education, and Welfare, *County Business Patterns, First Quarter, 1953*, Washington, 1955; and U. S. Bureau of the Census, *Annual Survey of Manufactures, 1953*, Washington, 1955. The latter offers material on total employment, production workers, value added, salaries and wages, and expenditures for plant and equipment.

[9] It is unfortunate that there has never been any critique published treating the relative reliability of the various enumerations in a given series or comparing the value of the different types of enumerations.

pair available at the initiation of this study.

That unfailing source of annoyance to the industrial geographer—the disclosure rule—is dealt with here by a simple method of estimation. In general, data on value added by manufacture have been withheld for a greater number of counties than have data for number of production workers. When the latter item is not given for two or more counties in a state, the assumption is made that the percentage of the total population engaged in manufacturing in the counties in question is uniform; and the "balancing item" (i.e., the total undisclosed value for the state) is apportioned among the counties in ratio to their total population. Undisclosed value added by manufacture is estimated in similar fashion. Assuming a uniform per-worker rate for value added in the withheld counties, the balancing item is divided by the reported or estimated number of production workers and distributed in proportion to the latter value. For studies in which greater precision is called for, more reliable values can be obtained through more laborious means;[10] but since the withholding of data for major industrial counties, such as Genesee County, Michigan, or Durham County, North Carolina, is fortunately rare, and the great majority of undisclosed counties of almost negligible moment on a national scale, the method outlined here suffices for this study.

Since 1939 and 1947 were intercensal years in terms of the Population Census, the population of the unit areas employed in this study was necessarily estimated. For the 1939 figures, the percentage of total state population was computed for each unit area for both 1930 and 1940, and a straight-line interpolation was made to estimate the percentage for mid-1939. The latter figure was then applied to the estimate for the total state population for 1939 as published by the Census. An identical procedure was followed in obtaining values for 1947.[11]

[10] See, for example, Kitagawa and Bogue, *op. cit.*, pp. 161–162.

THE DEMARCATION OF MANUFACTURING REGIONS

Past studies of industrial location in this country have arrayed their data on three levels of areal units: (1) counties and the various metropolitan districts delimited by the Census; (2) states; and (3) the nine Census divisions into which the states have been grouped. Although the states and census divisions possess the virtue of being familiar entities for which a tremendous variety of data has and will be tabulated, it is obvious not only that they are too gross in size but also that their boundaries are quite at variance with those of manufactural and other economic regions. The counties and metropolitan areas, on the other hand, also present serious difficulties. The sheer physical labor involved in handling the 3103 counties and quasi-county units (as of 1950) and the near-impossibility of an adequate reading of maps on which such a multitude of units have been plotted should give pause to any industrial geographer. Furthermore, the arbitrarily drawn county boundaries frequently interrupt closely knit economic areas, with the result that large numbers of workers reside on one side of a county line but are employed on the other side.

In order to meet the long-felt need

[11] The necessary estimates of state population are supplied in U. S. Bureau of the Census, *Estimated Population of the United States by States: 1910–1944*, Population—Special Reports, Series P-45, No. 9, Washington, 1945, and *Estimates of the Population of States: July 1, 1940 to 1949*, Current Population Reports, Population Estimates, Series P-25, No. 72, Washington, 1953.

for reporting units intermediate in scale between the county and the state, the Bureau of the Census in 1951 adopted Bogue's scheme for 501 State Economic Areas, a "functional grouping" of counties based upon a consideration of a large array of social and economic indices.[12] There can be little disagreement over the metropolitan SEA's, which are nearly identical with the Standard Metropolitan Areas that were established a short time before. The latter consists of "a central city (or cities) having 50,000 inhabitants or more, plus the whole county containing the central city, together with any other contiguous counties which have metropolitan characteristics and are socially and economically integrated with the central city and its surrounding county." The only additional qualification for the metropolitan SEA is that it must contain a minimum of 100,000 inhabitants.

Since serious questions can be raised concerning Bogue's system of non-metropolitan SEA's,[13] it is fortunate that the great bulk of the industrial output of the United States is concentrated within the relatively unobjectionable metropolitan SEA's. Although the criteria for the former appear to be primarily agricultural and a good many individual SEA's are cumbersome to handle because they are segmented into two or three isolated portions, it is also true that economic geographers have failed to develop any sound theoretical basis upon which the less industrialized portions of nations might be divided into meaningful regions. A further argument for the use of the Bogue system in its entirety is the advantage of having areal units for which other than purely industrial data will be readily accessible.

In setting up the system of areal units employed in this study (Fig. 1), several minor modifications were made in Bogue's original scheme. The metropolitan SEA's were defined upon the basis of 1950 population figures, with a view toward the ultimate extension of this study into the 1947–1954 period.[14] Where an SMA is intersected by a state line, the component SEA's have been combined and treated as a single areal unit. The total number of metropolitan SEA's so defined comes to 157. In the case of non-metropolitan SEA's, none of which cross state boundaries, certain areas which are designated separately only for agricultural purposes have been combined, in accordance with Bogue's suggestions, and a total of 302 areas derived, thus yielding a grand total of 459 SEA's. Whatever their limitations, it appears likely that where, as in this study, interregional labor commutation must be minimized, this assemblage of county-based SEA's works reasonably

[12] Donald J. Bogue, *State Economic Areas; A Description of the Procedure Used in Making a Functional Grouping of the Counties of the United States*, Bureau of the Census, Washington, 1951. The same scholar has also devised an elaborate hierarchy of economic regions in which the 501 SEA's are grouped into 119 Economic Subregions, 13 Economic Regions, and 5 Economic Provinces (Donald J. Bogue and Calvin L. Beale: *Economic Subregions of the United States*, U. S. Bureau of Agricultural Economics and Bureau of the Census, Series Census-BAE, No. 19, Washington, 1953, and Donald J. Bogue, "An Outline of the Complete System of Economic Areas," *Amer. Journ. of Soc.*, Vol. 60, 1954, pp. 136–139). Data from the 1950 Census of Population and the 1954 Census of Agriculture have already been published on the basis of SEA's, but there is as yet no indication of whether the broader groupings will also achieve official recognition. In any event, these larger regions are quite inapplicable to the needs of this paper, in spite of their being designed for the widest possible use.

[13] For a trenchant analysis of the virtues and shortcomings of Bogue's methodology, see Rutledge Vining: "Delimitation of Economic Areas: Statistical Conceptions in the Study of the Spatial Structure of an Economic System," *Journ. of Amer. Statist. Assn.*, Vol. 48, 1953, pp. 44–64.

[14] Although no systematic attempt was made to determine how many of the 1950 metropolitan SEA's reached that status after 1947, it is my impression that the number does not exceed four or five.

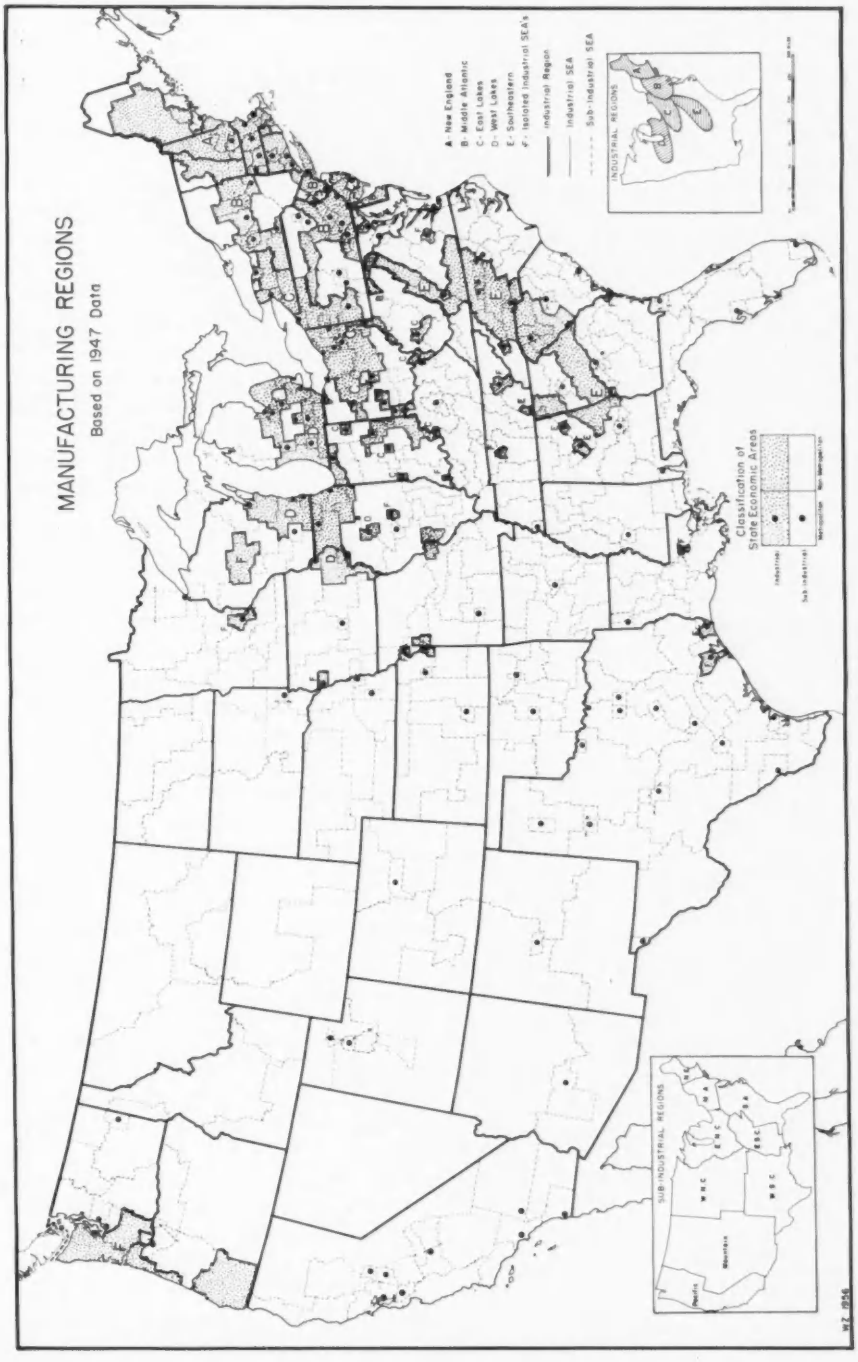

MANUFACTURING REGIONS
Based on 1947 Data
A. New England
B. Middle Atlantic
C. East Lakes
D. West Lakes
E. Southeastern
F. Isolated Industrial SEA's
Industrial Region
Industrial SEA
Sub-Industrial SEA
INDUSTRIAL REGIONS
Classification of State Economic Areas
Industrial
Sub-Industrial
Metropolitan
Non-Metropolitan
SUB-INDUSTRIAL REGIONS
NEC
MAC
ENC
WSC
ESC
ESC
WSC
Mountain
Pacific
WZ-1256

FIG. 1.

well. Cases can be cited, such as Milwaukee County or Ingham County (Lansing) where a substantial amount of daily commutation occurs across SEA boundaries because the problematical quasi-suburban counties were excluded; but a few such awkward decisions are inevitable.[15]

In previous attempts to delimit manufacturing regions within the United States there has been unanimous agreement as to the existence of a "Manufacturing Belt" in the northeastern quadrant of the nation, containing within its relatively small area the bulk of national industrial activity.[16] There is also general recognition of a "Southeastern Manufacturing Zone" occupying portions of the Southern Piedmont and Appalachian regions, while some authors also refer to a "California Manufacturing Zone."[17] Although much ingenuity has been exercised in plotting various indices to industrial activity and delineating these regions and their subdivisions, apparently no rigid criteria have been applied in mapping their boundaries; only a visual recognition of clusters of areas containing large absolute amounts of manufacturing activity.

It is here proposed that all the SEA's in the nation be sorted into two categories on the basis of the intensity of their industrial activity as of 1947: the Industrial and the Sub-Industrial. The latter term is used advisedly, instead of the more obvious "non-industrial," since the amount of manufacturing reported for all but a few of the less intensively industrialized SEA's is still massive by any world-wide criterion. Given ideal data, a formula might be developed whereby those areas producing more manufactured goods, as measured in terms of value added, than are consumed by their inhabitants would be called Industrial, whereas those producing less would be classified as Sub-Industrial. But two baffling problems in data procurement stand in our way. Firstly, since about 1870 the United States has exported considerably more manufactured goods than it has imported. In 1947, for example, the total value of semi-manufactured and manufactured items shipped to other countries came to approximately $11,824,000,000, whereas the aggregate value of the corresponding imports totaled only $2,884,000,000. Consequently, our industrial plants are turning out a product appreciably greater than that consumed by our population; but because of the incomparability of our data on foreign commerce and those on manufacturing, it is practically impossible to arrive at the pertinent figures. The second difficulty lies in the unfeasibility of computing regional differences in consumption of manufactured goods, both consumer and capital, although large masses of indirectly pertinent information are at hand.

The method adopted is extremely simple and only approximates the desired results. The 150 SEA's classified as industrial are those in which either or both the per-capita value added (Fig. 2) or the percentage of production

[15] The assumption is made that commuting across international boundaries at such places as Detroit, Buffalo, or El Paso is negligible.

[16] The most important attempts to map American manufacturing regions have been, in chronological order, Sten de Geer: "The American Manufacturing Belt," *Geografiska Annaler*, Vol. 4, 1927, pp. 237–354; Richard Hartshorne: "A New Map of the Manufacturing Belt of North America," *Econ. Geogr.*, Vol. 12, 1936, pp. 45–53; Helen M. Strong: "Regions of Manufacturing Intensity in the United States," *Annals of Assn. Amer. Geogrs.*, Vol. 27, 1937, pp. 23–43; and Clarence F. Jones: "Areal Distribution of Manufacturing in the United States," *Econ. Geogr.*, Vol. 14, 1938, pp. 217–222.

[17] National Resources Planning Board, *op. cit.*, p. 12; and G. E. McLaughlin: "Industrial Expansion and Location," *Annals of Amer. Acad. of Polit. and Soc. Sciences*, Vol. 242, 1945, pp. 25–29.

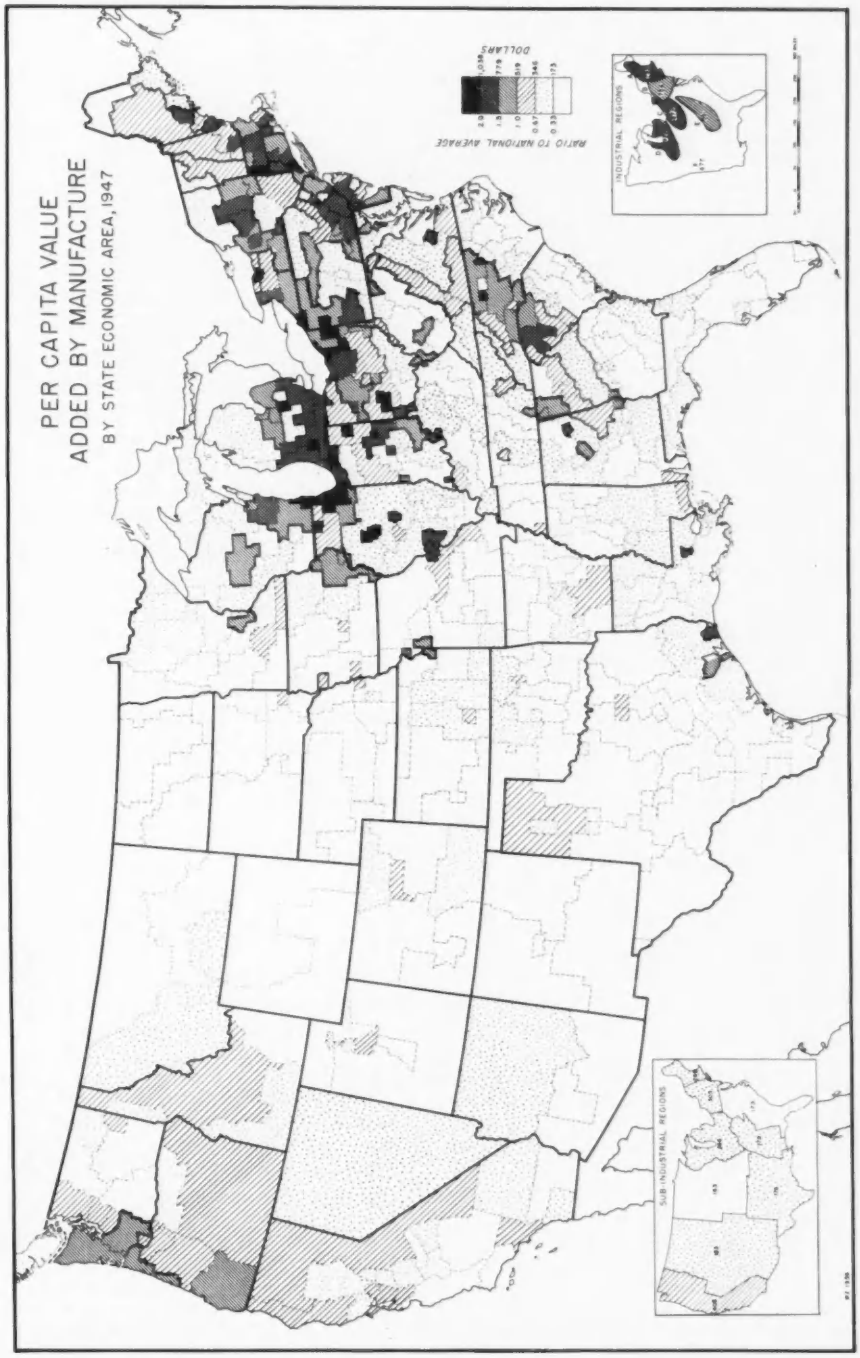

PER CAPITA VALUE
ADDED BY MANUFACTURE
BY STATE ECONOMIC AREA, 1947
DOLLARS
RATIO TO NATIONAL AVERAGE
INDUSTRIAL REGIONS
SUB-INDUSTRIAL REGIONS

FIG. 2.

workers among the total population equaled or exceeded the national averages in 1947 of $519 and 8.3 per cent, respectively. Similarly, those 309 SEA's which fail to meet this requirement fall into the sub-industrial class. Where both indices surpass the national averages, it seems safe enough to assume production in excess of consumption. Where only employment exceeds the critical figure, there is a strong presumption of a productivity rate low enough to bring about wage rates and, hence, consumption below the productivity rate. The weakest assumption is that the SEA with higher than average per-capita value added but less than average employment will not have a consumption rate above its productivity rate. A certain interval of grace is supplied by the difference between the national per-capita value-added rate and an appreciably lower consumption rate occasioned by the imbalance between our exports and imports. Undoubtedly, however, in this case as in the others, there are a few SEA's which have been incorrectly classified.

The next step was to group the industrial SEA's into a small number of industrial regions, mainly on the basis of contiguity. A plotting of manufacturing indices on a county basis and a consideration of the precise location of the more important industrial centers led to the system depicted in Figure 1. Within each of the five more or less concentrated industrial regions, namely, New England, Middle Atlantic, East Lakes, West Lakes, and Southeastern, the following condition holds true: the component SEA's are adjacent or, where they are not, the major industrial centers in the two non-contiguous SEA's in question are separated by a highway distance of 80 miles or less, so that they share at least part of a common labor market area (assuming that a commuting radius of 40 miles represents a reasonable maximum under current conditions). Obviously, certain boundary decisions were necessarily arbitrary and subject to revision by other students. This is particularly true of the assignment of certain SEA's in Ohio and Indiana to the East Lakes region rather than the West Lakes and the placement of the New England boundary along the traditional line, thus ignoring strong arguments for allotting western Connecticut to the New York City and, hence, the Middle Atlantic region. The classification of the block of SEA's in east-central New York State as Middle Atlantic rather than East Lakes is justified by a study of the county data and the location of the critical cities, as well as by the orientation of the area toward the Seaboard market.

It is clear that, taken together, the New England, Middle Atlantic, East Lakes, and West Lakes regions approximate the Manufacturing Belt as defined by De Geer, Hartshorne, and Jones,[18] in spite of interesting differences in details; and this larger entity is recognized throughout the accompanying tables. Although the Southeastern industrial region is contiguous and peninsular to the Manufacturing Belt, it is tabulated separately, along with the Isolated Industrial SEA's. The latter group consists of 21 industrial SEA's located in all sections of the nation which are too far separated from the recognized industrial regions to be attached to any of them.[19]

[18] There is also a marked degree of coincidence between the boundaries of the component regions of the Manufacturing Belt, as established for this study, and some of Hartshorne's and Jones' subregions or combinations thereof.

[19] The industrial classification of these Isolated Industrial SEA's in Washington and Oregon and in northern New England is, admittedly, an anomalous situation brought about largely by the inclusion of sawmills as manufacturing enterprises in a region of sparse population and otherwise limited industrial activity.

TABLE I

VALUE ADDED BY MANUFACTURE AND NUMBER OF PRODUCTION WORKERS, BY STATE ECONOMIC AREA AND MANUFACTURING REGION, 1939 AND 1947

Region	Number of SEA's			Value Added by Manufacture (in $1,000,000 and % of national total)						Number of Production Workers (in 1,000's and % of national total)					
				1939			1947			1939			1947		
	Met	Non Met	Tot.	Met	Non Met	Total	Met	Non Met	Total	Met	Non Met	Total	Met	Non Met	Total
INDUSTRIAL REGIONS															
A. New England	10	8	18	2,046	320	2,366	5,718	919	6,637	770	155	924	1,018	173	1,191
				8.2	1.3	9.5	7.6	1.2	8.9	9.8	2.0	11.7	8.5	1.5	10.0
B. Middle Atlantic	14	11	25	5,514	386	5,901	15,537	1,172	16,710	1,630	165	1,816	2,289	251	2,540
				22.3	1.5	23.9	20.8	1.5	22.4	20.9	2.1	23.0	19.2	2.1	21.3
C. East Lakes	22	10	32	3,553	584	4,137	10,267	1,946	12,213	967	202	1,169	1,577	322	1,899
				14.3	2.3	16.7	13.7	2.6	16.4	12.3	2.6	14.8	13.2	2.7	15.9
D. West Lakes	18	11	29	4,157	647	4,804	12,133	2,145	14,277	1,121	192	1,313	1,763	333	2,097
				16.8	2.6	19.5	16.3	2.9	19.2	14.2	2.4	16.6	14.8	2.8	17.6
Manufacturing Belt	64	40	104	15,270	1,938	17,208	43,655	6,181	49,836	4,508	714	5,221	6,647	1,081	7,728
				61.9	7.8	69.7	58.6	8.3	66.9	57.2	9.0	66.2	55.7	9.1	64.8
E. Southeastern	11	14	25	431	554	985	1,306	1,972	3,278	177	337	514	237	449	685
				1.8	2.2	4.0	1.8	2.6	4.4	2.2	4.3	6.5	2.0	3.8	5.8
F. Isolated Industrial SEA's	16	5	21	1,430	153	1,584	4,220	500	4,719	362	52	415	591	68	659
				5.8	0.6	6.4	5.7	0.7	6.3	4.6	0.7	5.3	5.0	0.6	5.5
Total Industrial	91	59	150	17,132	2,646	19,778	49,181	8,653	57,834	5,047	1,103	6,150	7,474	1,597	9,072
				69.4	10.7	80.1	66.1	11.6	77.7	64.0	14.0	78.0	62.7	13.4	76.1
SUB-INDUSTRIAL REGIONS															
New England	1	5	6	22	40	62	64	112	177	9	20	29	12	24	36
				0.1	0.2	0.3	0.1	0.1	0.2	0.1	0.3	0.4	0.1	0.2	0.3
Middle Atlantic	5	8	13	123	235	358	365	702	1,067	55	90	144	87	134	221
				0.5	0.9	1.4	0.5	0.9	1.4	0.7	1.1	1.8	0.7	1.1	1.9
East North Central	2	28	30	37	501	538	105	1,633	1,738	9	190	199	18	324	343
				0.2	2.0	2.2	0.1	2.2	2.3	0.1	2.4	2.5	0.2	2.7	2.9
West North Central	8	47	55	146	382	529	505	1,094	1,600	38	125	163	77	202	279
				0.6	1.5	2.1	0.7	1.5	2.1	0.5	1.6	2.1	0.6	1.7	2.3
Northeast	16	88	104	328	1,158	1,487	1,039	3,542	4,581	111	425	536	195	685	880
				1.3	4.7	6.0	1.4	4.8	6.2	1.4	5.4	6.8	1.6	5.8	7.4
South Atlantic	11	38	49	288	389	676	792	1,373	2,164	98	214	312	136	314	450
				1.2	1.6	2.7	1.1	1.8	2.9	1.2	2.7	4.0	1.1	2.6	3.8
East South Central	5	33	38	100	282	381	358	1,199	1,557	34	172	206	57	274	331
				0.4	1.1	1.5	0.5	1.6	2.1	0.4	2.2	2.6	0.5	2.3	2.8
West South Central	17	43	60	311	292	604	1,088	1,170	2,258	90	131	221	163	206	369
				1.3	1.2	2.4	1.5	1.6	3.0	1.1	1.7	2.8	1.4	1.7	3.1
South	33	114	147	699	962	1,662	2,238	3,742	5,980	222	517	739	356	794	1,150
				2.8	3.9	6.7	3.0	5.0	8.0	2.8	6.5	9.4	3.0	6.7	9.7
Mountain	5	24	29	97	177	274	305	530	835	23	46	70	45	70	115
				0.4	0.7	1.1	0.4	0.7	1.1	0.3	0.6	0.9	0.4	0.6	1.0
Pacific	12	17	29	1,236	246	1,483	4,328	867	5,195	307	85	392	583	116	699
				5.0	1.0	6.0	5.8	1.2	7.0	3.9	1.1	5.0	4.9	1.0	5.9
West	17	41	58	1,333	424	1,757	4,633	1,397	6,030	330	131	461	629	186	815
				5.4	1.7	7.1	6.2	1.9	8.1	4.2	1.7	5.8	5.3	1.6	6.8
Total Sub-Industrial	66	243	309	2,361	2,544	4,905	7,911	8,680	16,591	662	1,073	1,736	1,179	1,665	2,844
				9.6	10.3	19.9	10.6	11.7	22.3	8.4	13.6	22.0	9.9	14.0	23.9
GRAND TOTAL	157	302	459	19,493	5,190	24,683	57,092	17,334	74,426	5,710	2,177	7,886	8,654	3,262	11,916

The remaining 309 sub-industrial SEA's have been grouped into nine sub-industrial regions equivalent to the Census divisions minus the industrial SEA's.[20] The principal plea for so feeble a system of "rump" regions is that, in lieu of a theoretical foundation for a better grouping, the relatively minor manufacturing activity involved would not justify the extensive experimentation needed to achieve a superior system. In Table I the basic data employed in this study have been arrayed by region and by metropolitan and non-metropolitan categories.

[20] Except in the case of Douglas County, Wisconsin, which, as a portion of the Duluth SMA, has been annexed to the West North Central sub-industrial region.

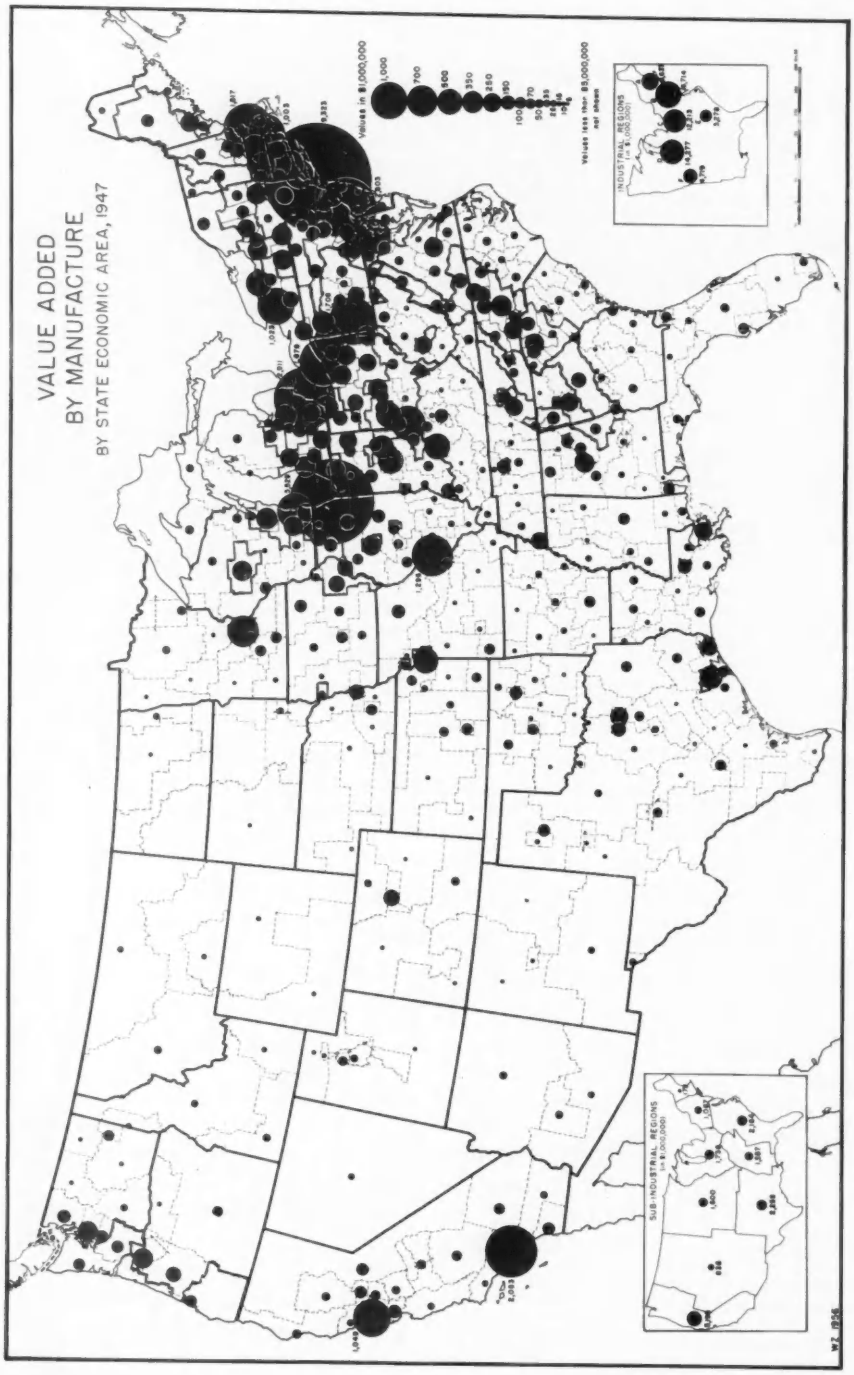

VALUE ADDED
BY MANUFACTURE
BY STATE ECONOMIC AREA, 1947
Values in $1,000,000
1,000
750
500
350
250
200
100
50
25
10
5
Values less than $5,000,000 not shown
INDUSTRIAL REGIONS
1 = $20,000
SUB-INDUSTRIAL REGIONS
1 = $1,000,000
WZ-856

FIG. 3.

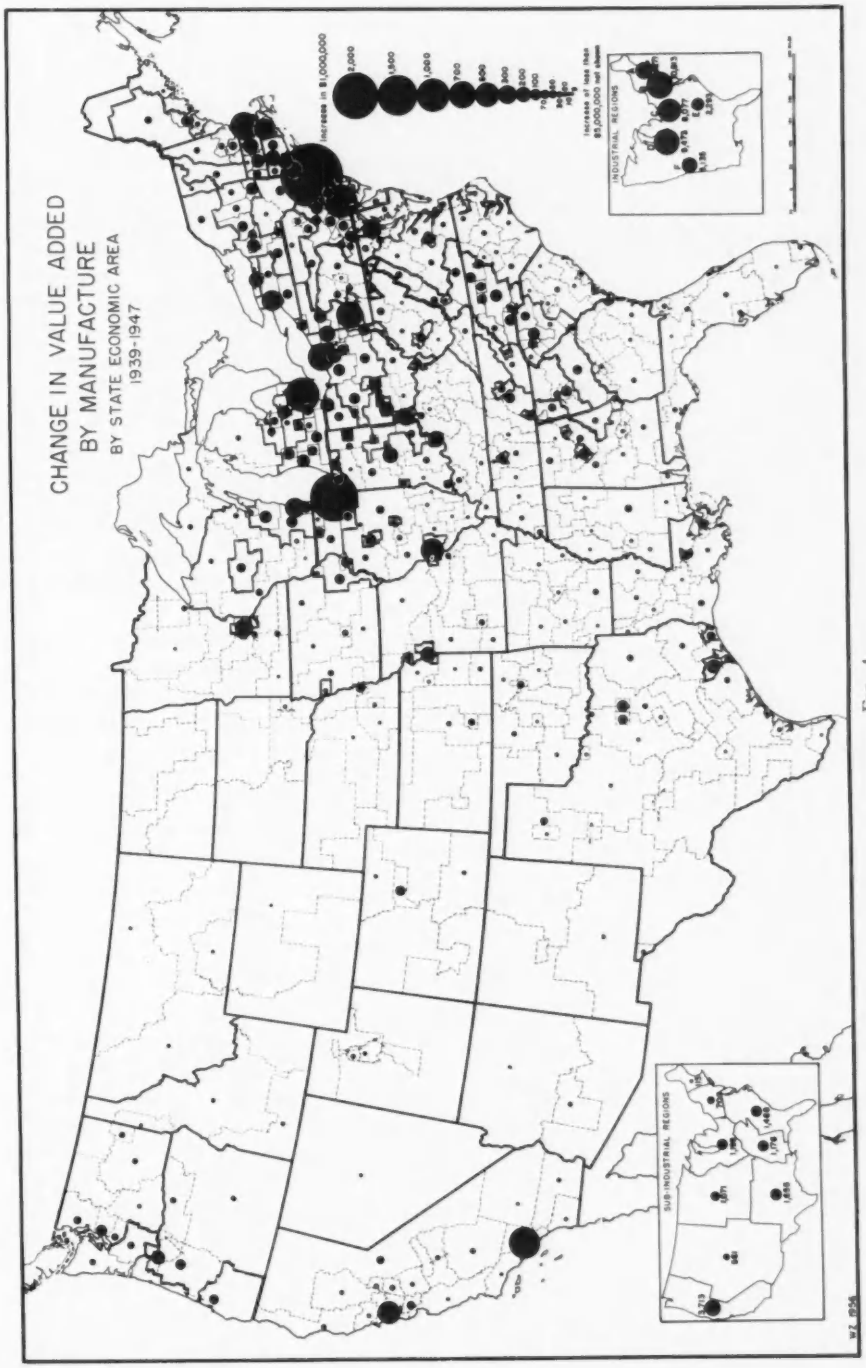

CHANGE IN VALUE ADDED
BY MANUFACTURE
BY STATE ECONOMIC AREA
1939-1947
INDUSTRIAL REGIONS
SUB-INDUSTRIAL REGIONS

FIG. 4

THE DEFINITION OF TERMS DESCRIBING DISTRIBUTIONAL CHANGE

The problem of finding an adequate method for measuring change in manufacturing activity among the areas specified for this study had best be prefaced by some explanation of the terms involved. A veritable semantic jungle has sprouted around the popular, but loosely applied, term "decentralization." In this discussion the terminology arrived at by Creamer[21] and Woodbury[22] will be adhered to, since it appears to be the most logical and meaningful. Thus "decentralization" and "centralization" denote a decrease or increase, respectively, in the concentration of manufacturing activity within a given area as contrasted to the larger region with which it is being compared. These terms as used here do *not* refer to change in the distribution of production within a single corporation nor to the so-called monopolization or control of various firms within a given industry.[23] "Diffusion" in the Creamer–Woodbury lexicon denotes the process of decentralization within a metropolitan region; and "dispersion" means decentralization either from a metropolitan region to the areas adjoining it (i.e., more or less *intra*-regional movement) or from one major region into another (i.e., *inter*-regional). It is regrettable that the single term "dispersion" covers intra- and inter-regional change and that the badly needed antonym is not offered. Creamer, Woodbury, and Kitagawa-Bogue have among them diligently explored nearly all accessible aspects of "diffusion" for the period 1899–1947; but they and other scholars have accorded relatively scant attention to "dispersion," particularly the inter-regional variety; and it is this comparatively neglected topic, then, that will be given priority in this investigation.

It must be understood that the use of such terms as "distributional change," "industrial migration," "locational shifts," or the like involves no judgment as to the means whereby such change is effected. In actuality, several processes are at work: the expansion or contraction of plant capacity or activity in existing establishments, the differential regional natality and mortality of plants, varying technical progress in production methods among different regions, and last, and, probably least, the actual transference of plants from one locality to another. The examination of this interesting and highly important matter lies beyond the scope of the present paper, which is concerned with the results rather than the mechanics of change.

THE MEASUREMENT OF DISTRIBUTIONAL CHANGE: THE M FACTOR

The most primitive method for representing change in the spatial distribution of any variable is to express its locational pattern at various points in time through a series of maps or other media and to invite the reader to make his own visual inferences. Somewhat more informative is the map (e.g., Fig. 4) or table in which change is shown in either absolute or percentile terms;[24] but this method also falls far short of the desired end. Unless the distributional pattern is quite simple and the relative regional changes of a radical character,

[21] Daniel B. Creamer: *Is Industry Decentralizing? A Statistical Analysis of Locational Change in Manufacturing Employment, 1899–1923*, Philadelphia, 1935.

[22] Woodbury, *op. cit.*, pp. 207–211.

[23] The latter phenomenon is explored in considerable detail in *Report of the Federal Trade Commission on Changes in Concentration in Manufacturing, 1935 to 1947 and 1950*, Washington, 1954.

[24] For examples of such maps, see John W. Alexander: "Industrial Expansion in the United States, 1939–1947," *Econ. Geogr.*, Vol. 28, 1952, pp. 128–142.

it is generally beyond the capacity of the human eye to ascertain how much relative change has in fact occurred. A perusal of Figures 3 and 4 simply indicates great increases in value added throughout the nation; but since the initial pattern was markedly uneven, all that can be concluded is that the areas of greatest volume of industrial activity (and, judging from Figure 2, also generally the greatest intensity) are those that have gained the most.[25] The situation would be only slightly improved by adding a map showing percentile change.[26]

It is apparent, then, that maps and tables depicting various indices to manufacturing and their absolute and percentile change, while intrinsically important, must be supplemented by additional items.[27] One of the more useful of these is the representation of change in "concentration," which may be defined as the percentage of the total value in a universe—here the United States—to be found within the unit area. Thus if Area X has 2.5 per cent of the national total of any given variable in the earlier year and 3.6 per cent in the latter year, it has experienced an increase in concentration of 1.1, which can be translated, if need be, into absolute terms. This type of computation eliminates concern over increase or decrease in the national total or, in the case of a monetary index, temporal change in the value of the unit employed, and concentrates attention on sub-national shifts in distribution ("dispersion" and the opposite process). It is proposed that this type of index to distributional change—the difference through time in the fraction of the national total found within a given unit area—which may be applied to an unlimited variety of mappable quantitative phenomena, be termed generically the M factor.[28] In Figures 5, 6, and 7 the M factor has been computed for value added, production workers, and total population, converted into absolute terms, plotted by SEA, and designated the V, E, and P factors, respectively. These drawings, along with Tables II and III, afford a clear and relatively concise picture of the direction and absolute amount of change in the regional distribution ("dispersion" and "counter-dispersion") of the phenomena in question.

It has been previously stated, in considering suitable indices for industrial

[25] The conversion of 1947 into 1939 dollars, which was not attempted for Figure 4, would have altered the map only in detail, not in basic configuration.

[26] Figure 4 and the other maps showing change in this study of national trends employ the absolute method for two good reasons: the extreme variation in the magnitude of the statistical base and an equally large range in the areas of the unit regions. Thus, to take an extreme example, an increase of 100 per cent in the manufacturing activity of Nevada with its huge area actually involves less absolute value than a 10 per cent increase in the minute Milwaukee SEA; yet all but the wariest map readers would be led to assume the opposite from a map showing only percentile change. When the focus of interest lies in the local situation, percentile change assumes much greater importance. In such a study the addition of industries contributing, say, $10,000,000 of value added annually would be handled differently from one locality to another: in the case of New York City it would generate barely a ripple of comment, but in a community such as Nantucket it would have cataclysmic effects.

[27] A method that offers interesting, if limited possibilities is centrographic analysis. A map showing center of manufactures from 1849 to 1919, computed according to some undefined method, appears in U. S. Bureau of the Census, *Fourteenth Census of the United States Taken in the Year 1920, Volume VIII, Manufactures, 1919*, Washington, 1922, p. 8. A brief discussion of trends in the center of gravity for wage earners in manufacturing is to be found in Tracy E. Thompson: *Location of Manufactures, 1899–1929; a Study of the Tendencies toward Concentration and toward Dispersion of Manufactures in the United States*, U. S. Bureau of the Census, Washington, 1933, pp. 7–9.

[28] The same principle has been utilized, though in somewhat different fashion, in Daniel Creamer: "Shifts in Manufacturing Industries," in National Resources Planning Board, *op. cit.*, pp. 87–90; McCarty, *op. cit.*; and Raymond E. Murphy: "The Relative Change Map," *Professional Geographer*, Vol. 5, 1953, pp. 4–5.

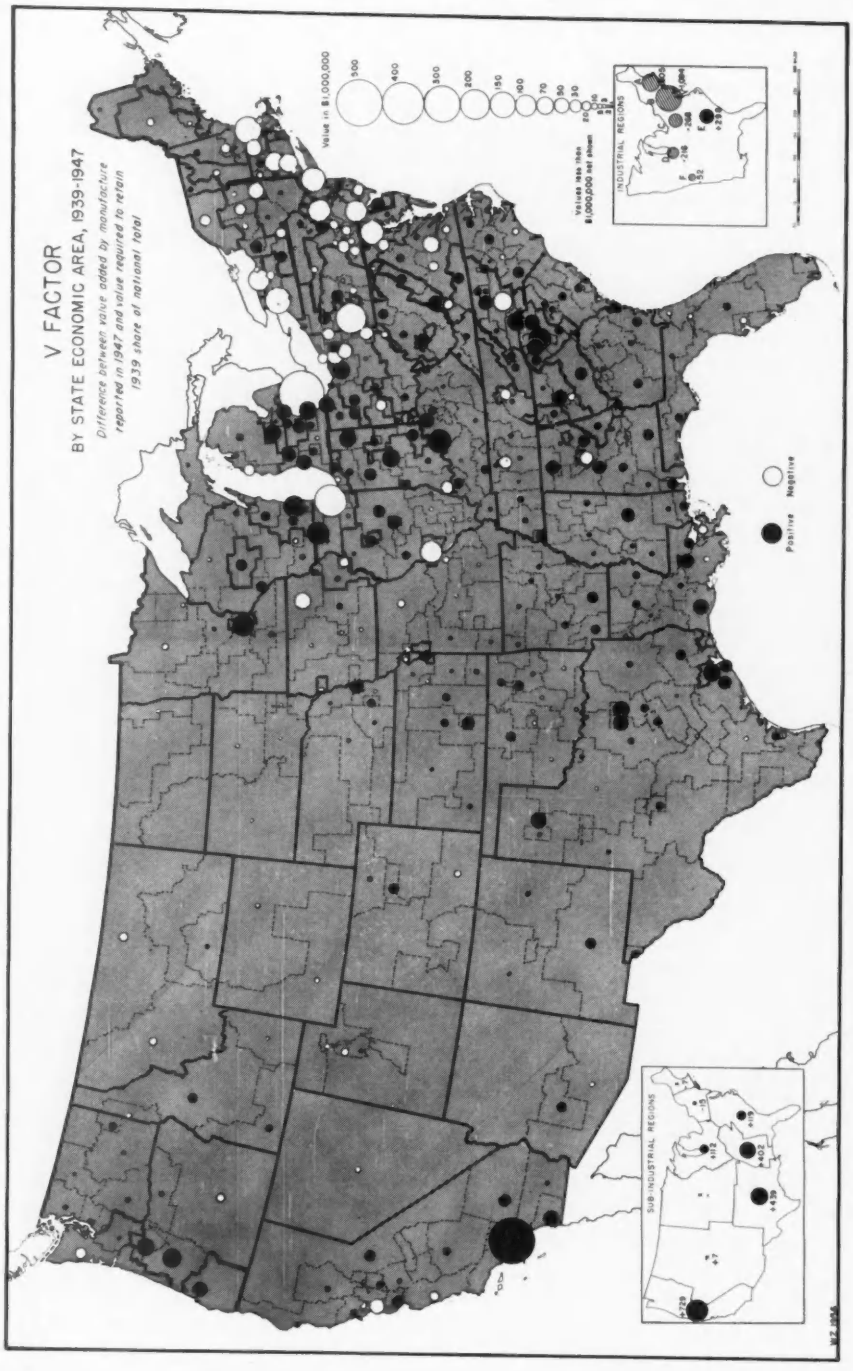

V FACTOR
BY STATE ECONOMIC AREA, 1939-1947
Difference between value added by manufacture reported in 1947 and value required to retain 1939 share of national total
Value in $1,000,000
500
400
300
200
100
90
70
50
30
20
10
5
1
Values less than $1,000,000 not shown
INDUSTRIAL REGIONS
SUB-INDUSTRIAL REGIONS
Positive
Negative

FIG. 5.

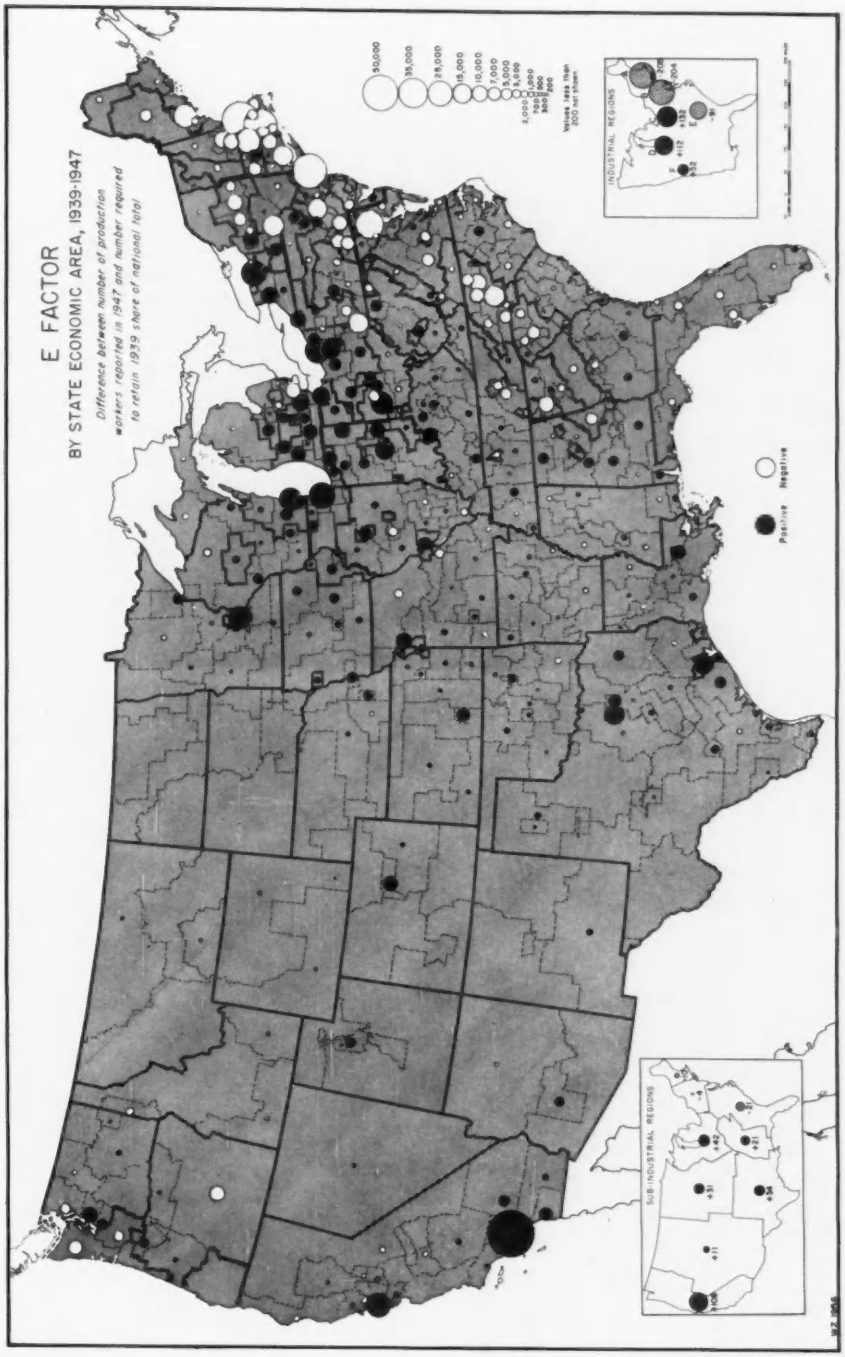

E FACTOR
BY STATE ECONOMIC AREA, 1939-1947
Difference between number of production workers reported in 1947 and number required to retain 1939 share of national total
50,000
35,000
25,000
15,000
10,000
7,000
5,000
3,000
2,000
1,000
500
300
200
Values less than 200 not shown
Positive
Negative
INDUSTRIAL REGIONS
SUB-INDUSTRIAL REGIONS

FIG. 6.

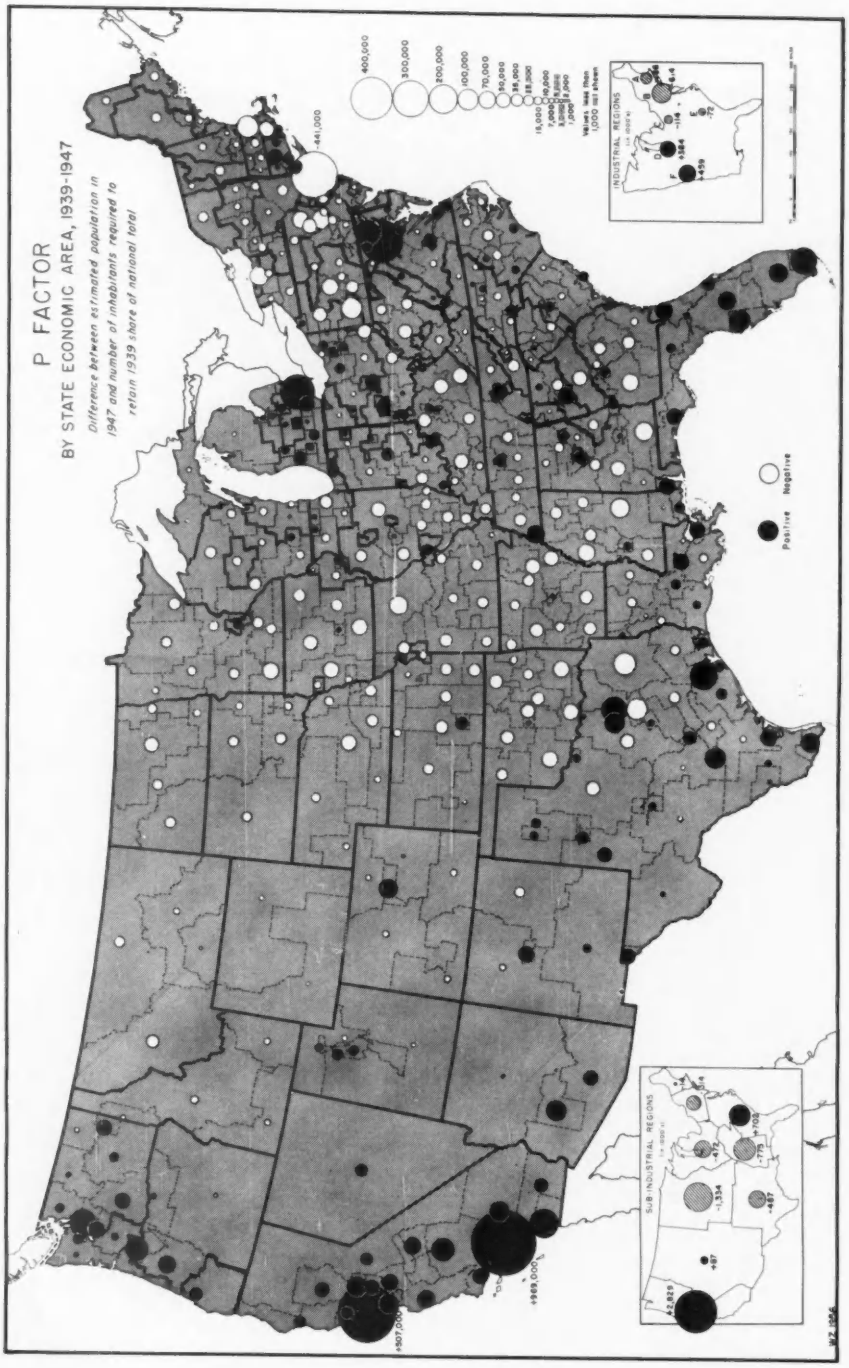

P FACTOR
BY STATE ECONOMIC AREA, 1939-1947
Difference between estimated population in 1947 and number of inhabitants required to retain 1939 share of national total
400,000
300,000
200,000
100,000
70,000
35,000
18,000
10,000
5,000
2,500
1,000
Values less than 1,000 not shown
Positive
Negative
INDUSTRIAL REGIONS
SUB-INDUSTRIAL REGIONS
+441,000
+907,000
+969,000

FIG. 7.

TABLE II

CHANGE IN THE RELATIVE DISTRIBUTION OF VALUE ADDED BY MANUFACTURE, BY STATE ECONOMIC AREA AND MANUFACTURING REGION, 1939–1947

Region	Per Capita Value Added by Manufacture (in dollars)						V Factor 1939–1947 (in $1,000,000 value)			V:P Factor 1939–1947 and % of 1947		
	1939			1947								
	Met	Non Met	Total	Met	Non Met	Total	Met	Non Met	Total	Met	Non Met	Total
INDUSTRIAL REGIONS												
A. New England	311	220	303	835	604	793	-454 7.9	-51 5.5	-505 7.6	-292 5.1	-7 0.8	-299 4.5
B. Middle Atlantic	294	195	289	773	574	711	-1094 7.2	-- --	-1094 6.6	-452 2.9	+88 7.5	-364 2.2
C. East Lakes	353	209	322	935	656	872	-447 4.3	+179 9.2	-268 2.2	-147 1.4	+265 13.6	+118 0.9
D. West Lakes	405	240	371	1048	715	979	-409 3.4	+194 9.1	-216 1.5	-591 4.8	+182 8.5	-408 2.9
Manufacturing Belt	336	217	317	882	648	828	-2405 5.5	+322 5.4	-2083 4.2	-1481 3.4	+528 8.5	-953 1.9
E. Southeastern	249	164	193	660	553	591	-- --	+298 15.1	+298 9.1	-31 2.4	+437 22.2	+406 12.4
F. Isolated Industrial SEA's	273	211	266	689	596	677	-88 2.1	+37 7.4	-52 1.1	-306 7.3	+56 11.2	-250 5.3
Total Industrial	321	203	303	854	618	809	-2493 5.7	+657 10.9	-1836 3.6	-1818 4.2	+1021 16.5	-796 1.6
SUB-INDUSTRIAL REGIONS												
New England	150	84	99	414	224	269	-- --	-7 5.9	-7 4.0	+1 1.6	-3 2.7	-2 1.1
Middle Atlantic	95	106	102	297	309	305	-7 1.9	-7 1.0	-15 1.4	+53 14.8	+39 5.6	+92 8.6
East North Central	150	81	84	378	245	266	-7 6.7	+119 7.3	+112 7.0	-8 7.6	+248 15.2	+240 13.9
West North Central	117	43	52	374	129	163	+60 11.8	-60 5.5	-- --	+77 15.2	+62 5.7	+139 8.7
Northeast	111	65	72	345	202	223	+44 3.5	+45 1.7	+90 1.9	+124 11.9	+345 9.7	+469 10.2
South Atlantic	97	49	63	190	165	173	-82 10.4	+201 14.7	+119 5.5	-249 31.5	+200 14.7	-49 2.3
East South Central	114	36	44	362	155	179	+52 14.5	+350 29.1	+402 25.8	+11 3.1	+402 33.5	+413 26.5
West South Central	106	32	50	290	129	176	+149 13.7	+290 24.8	+440 19.4	+12 1.1	+395 33.8	+407 18.0
South	105	38	53	250	149	176	+119 5.3	+841 22.5	+960 16.1	-226 10.1	+997 26.7	+771 12.9
Mountain	106	56	67	250	159	183	+15 4.9	-7 1.3	+7 0.9	-39 12.8	+24 4.5	-15 1.7
Pacific	184	103	163	448	272	405	+647 13.8	+134 15.4	+781 14.0	-429 9.9	-- --	-429 8.2
West	174	76	133	426	214	347	+662 13.2	+127 9.1	+788 12.2	-468 10.1	+24 1.7	-444 7.4
Total Sub-Industrial	117	53	75	347	177	231	+825 9.8	+1012 11.9	+1836 10.9	-570 7.2	+1366 15.7	+796 4.8
GRAND TOTAL	279	85	188	710	275	519	-1668 3.0	+1668 9.9	--	-2387 4.2	+2387 13.8	--

activity, that some attention should be accorded the amount of value added per worker, i.e., the productivity rate. This is an item which cannot, however, be treated as an M factor since it is a ratio rather than a quantity. Although it is a simple mathematical proposition that the V factor represents the sum of two components—the change in concentration attributable to the E factor,

TABLE III

CHANGE IN THE RELATIVE DISTRIBUTION OF PRODUCTION WORKERS, BY STATE ECONOMIC AREA AND MANUFACTURING REGION, 1939–1947

Region	Production Workers as Percentage of Total Population						E Factor 1939–1947 (in 1,000's and % of 1947 production workers)			E:P Factor 1939–1947		
	1939			1947								
	Met	Non Met	Total	Met	Non Met	Total	Met	Non Met	Total	Met	Non Met	Total
INDUSTRIAL REGIONS												
A. New England	12.1	10.7	11.9	14.8	11.4	14.3	-145 14.2	-60 34.7	-205 17.2	-106 10.4	-33 19.1	-139 11.8
B. Middle Atlantic	8.8	8.4	8.7	11.4	12.3	11.5	-206 9.0	+2 0.8	-204 8.0	-131 5.7	-3 1.2	-134 5.3
C. East Lakes	9.5	7.2	9.1	14.3	10.8	13.6	+114 7.2	+18 5.6	+132 5.9	+135 8.5	+22 6.9	+157 8.3
D. West Lakes	10.9	7.1	10.2	15.2	11.1	14.4	+69 3.9	+42 12.7	+112 5.3	+28 1.6	+39 11.8	+67 3.2
Manufacturing Belt	9.9	8.0	9.6	13.4	11.3	13.1	-168 2.5	+4 0.4	-164 2.1	-74 1.1	+26 2.4	-48 0.6
E. Southeastern	10.2	10.0	10.1	11.9	12.6	12.4	-30 12.7	-61 13.6	-91 13.3	-37 15.6	-39 8.5	-76 11.1
F. Isolated Industrial SEA's	7.0	7.2	7.0	9.6	8.1	9.4	+44 7.5	-12 17.6	+32 4.8	+13 2.2	-13 19.1	-- --
Total Industrial	9.6	8.5	9.4	12.9	11.4	12.7	-152 2.0	-69 4.3	-220 2.4	-98 1.2	-26 1.6	-124 1.4
SUB-INDUSTRIAL REGIONS												
New England	6.4	4.2	4.7	7.8	4.6	5.5	-2 16.7	-7 29.1	-10 27.8	-1 8.3	-5 21.0	-7 19.4
Middle Atlantic	4.2	4.1	4.1	7.1	5.9	6.3	+5 5.7	-1 0.8	+4 1.8	+18 2.1	+9 6.7	+27 12.2
East North Central	3.4	3.1	3.1	6.7	5.2	5.2	+6 32.0	+36 11.1	+42 12.3	+5 27.0	+37 11.4	+43 12.5
West North Central	3.1	1.4	1.6	5.7	2.4	2.8	+18 23.4	+13 20.8	+31 11.1	+19 24.7	+37 18.3	+57 20.4
Northeast	3.7	2.4	2.6	6.5	3.9	4.3	+24 9.2	+42 6.1	+66 7.5	+42 21.5	+78 11.4	+120 13.6
South Atlantic	3.3	2.7	2.9	3.2	3.8	3.6	-13 9.6	-8 2.5	-21 4.7	-38 28.0	-- --	-38 8.4
East South Central	4.3	2.2	2.4	5.8	3.5	3.8	+6 10.5	+15 5.5	+21 6.3	-2 3.5	+38 13.9	+36 10.9
West South Central	3.1	1.4	1.8	4.3	2.2	2.9	+27 16.6	+7 3.4	+34 9.2	+9 5.6	+29 11.1	+39 10.6
South	3.3	2.1	2.3	4.0	3.2	3.4	+20 5.6	+14 1:7	+35 3.0	-31 8.7	+67 8.4	+36 3.1
Mountain	2.5	1.4	1.7	3.7	2.1	2.5	+11 24.3	-- --	+11 15.7	+7 15.5	+1 --	+7 10.0
Pacific	4.6	3.5	4.3	6.0	3.7	5.5	+119 20.4	-11 9.9	+108 15.4	-7 1.2	-32 28.5	-39 5.6
West	4.3	2.3	3.5	5.8	2.8	4.7	+130 20.6	-11 6.9	+119 14.6	-- --	-32 17.5	-32 3.9
Total Sub-Industrial	3.8	2.2	2.6	5.2	3.4	4.0	+176 14.9	+44 2.6	+220 7.8	+11 1.0	+113 6.7	+124 4.4
Grand Total	8.2	3.6	6.0	10.8	5.2	8.3	+24 0.3	-24 0.7	-- --	-87 1.0	+87 2.6	-- --

or number of employees, and the amount accounted for by relative change in productivity—and that the last term could be derived by subtracting the E from the V factor, this operation will not be hazarded at this point, partly because

of the considerable difficulty of converting production workers into their exact equivalent in value added.

ALLOWING FOR POPULATION CHANGE: THE M:P FACTOR

There now remains the formidable task of measuring the distributional change in the two indices which take cognizance of total population—per-capita value added and production workers as a percentage of total population. Although the same general principle underlies such measures, which belong to a class which will be designated generically as the M:P factors, as applies to the M factor, namely, the indication of change in degree of concentration, it is much more difficult to perform this operation when one variable, i.e., manufacturing activity, is to be treated as a function of another, i.e., total population. Of the great variety of possible mathematical treatments, the one submitted here is the simplest meeting the requirements of the situation, but not necessarily the best. It may be written as follows:

$$\text{M:P factor} = m_{1947} - \frac{m_{1939} \cdot p_{1947} \cdot k}{p_{1939}}$$

where m is the amount of manufacturing activity in any given unit area,
p is the total population of the unit area,
k is a constant used for all the unit areas in the nation, approaching in value the ratio between the national m/p rate for 1947 over the same ratio for 1939, such that $\Sigma M:P = 0$.

In verbal terms, the M:P factor is the difference between the reported value and the projected value when the latter is the population in the latter year multiplied by the per-capita ratio of manufacturing in the earlier year after it has been multiplied by approximately the quotient of the national ratio in the latter year divided by the national ratio in the earlier year. More simply, the V:P factor, an M:P factor that has been plotted in Figure 8, is the value that would have to be added to or subtracted from all the various SEA's in the nation in order that the per-capita value-added ratio might everywhere have increased at a uniform rate between 1939 and 1947. And, similarly, the E:P factor (Fig. 9) is the number of production workers that would have to be given to or taken from the individual SEA's of the country if the percentage of production workers among total population had increased at a uniform rate during the study period. As was the case with M factors, the M:P factors can be expressed in either absolute or percentile terms.[29] It must be added that the utility of this formula is not limited to the specific problem at hand. M and P can be any two variable phenomena between which there is some sort of essentially linear functional relationship. Thus, to take two random examples, the M:P factor could be plotted for number of farmers as against total labor force or retail grocery sales in relation to total disposable income. In Figure 10, the M:P factor has been worked out for value added as "normalized" for number of production workers, i.e., relative change in distribution of value added that can be accounted for by differential rates of change in per-worker productivity. There is the further possibility that mathematical formulae can be developed to cover the functional

[29] One of the attractive features of the M:P factor is its substantial elimination of so-called "ubiquitous" or "non-basic" industries, those more or less universal enterprises serving local markets, among which bottling works, many dairy plants, feed mills, bakeries, certain printing establishments, brickyards, and shops producing advertising signs may be numbered. Instead, the M:P factor focuses attention on those "basic" industries which cater to the larger region or the nation. Hartshorne, *op. cit.*, recognizes this problem and attempts to cancel out the ubiquitous industries by subtracting a flat percentage from the number of manufacturing employees.

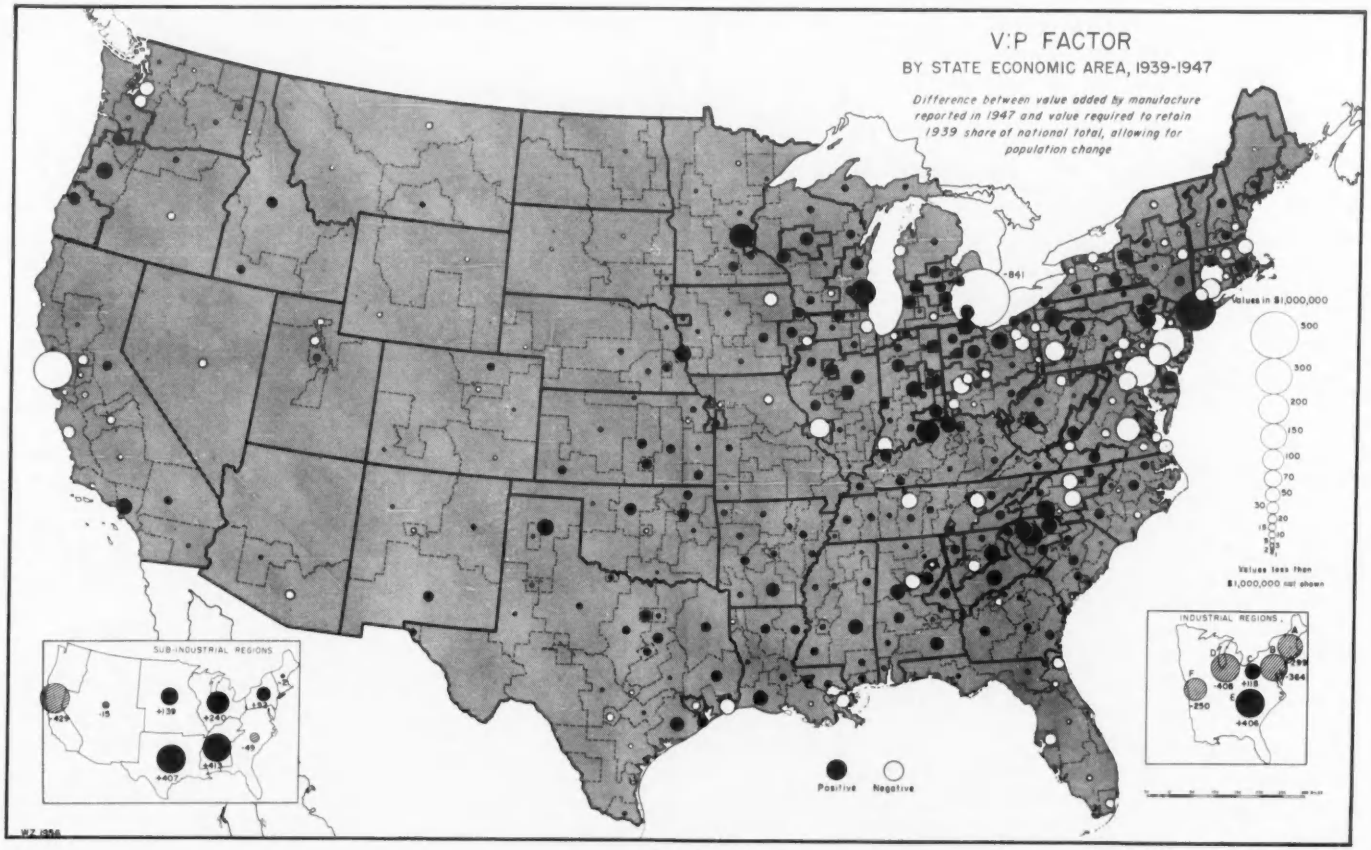

V:P FACTOR
BY STATE ECONOMIC AREA, 1939-1947
Difference between value added by manufacture reported in 1947 and value required to retain 1939 share of national total, allowing for population change
-841
Values in $1,000,000
500
300
200
150
100
70
50
30
20
10
Values less than $1,000,000 not shown
SUB-INDUSTRIAL REGIONS
+429
-15
+139
+240
-133
-49
+413
+407
INDUSTRIAL REGIONS
A
B
C
D
E
F
+98
364
-408
+118
-250
+406
Positive
Negative
WZ 1358

FIG. 8.

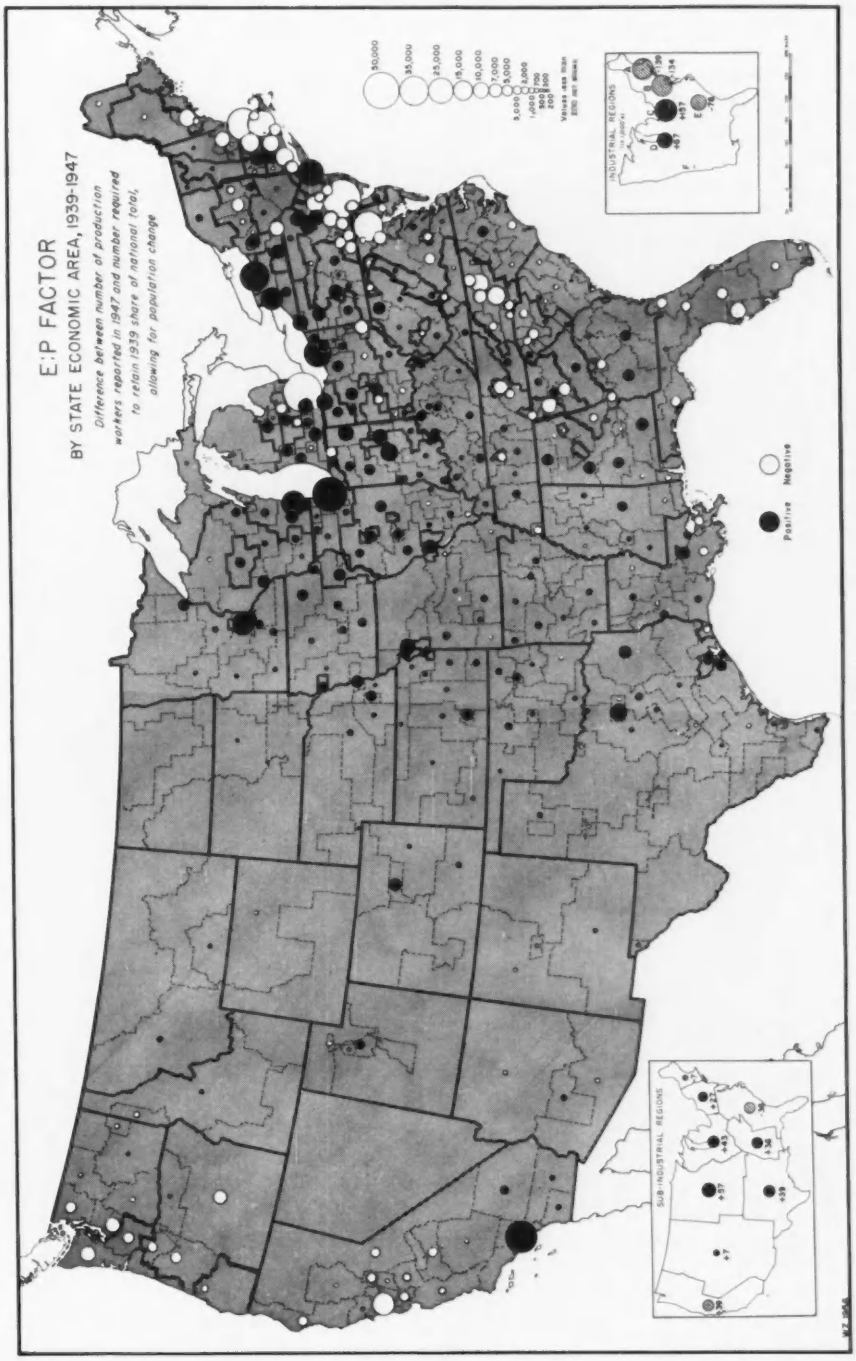

E:P FACTOR
BY STATE ECONOMIC AREA, 1939-1947
Difference between number of production workers reported in 1947 and number required to retain 1939 share of national total, allowing for population change
50,000
35,000
25,000
15,000
10,000
7,000
5,000
3,000
2,000
1,000
500
250
Values less than 250 not shown
Positive
Negative
INDUSTRIAL REGIONS
SUB-INDUSTRIAL REGIONS

FIG. 9.

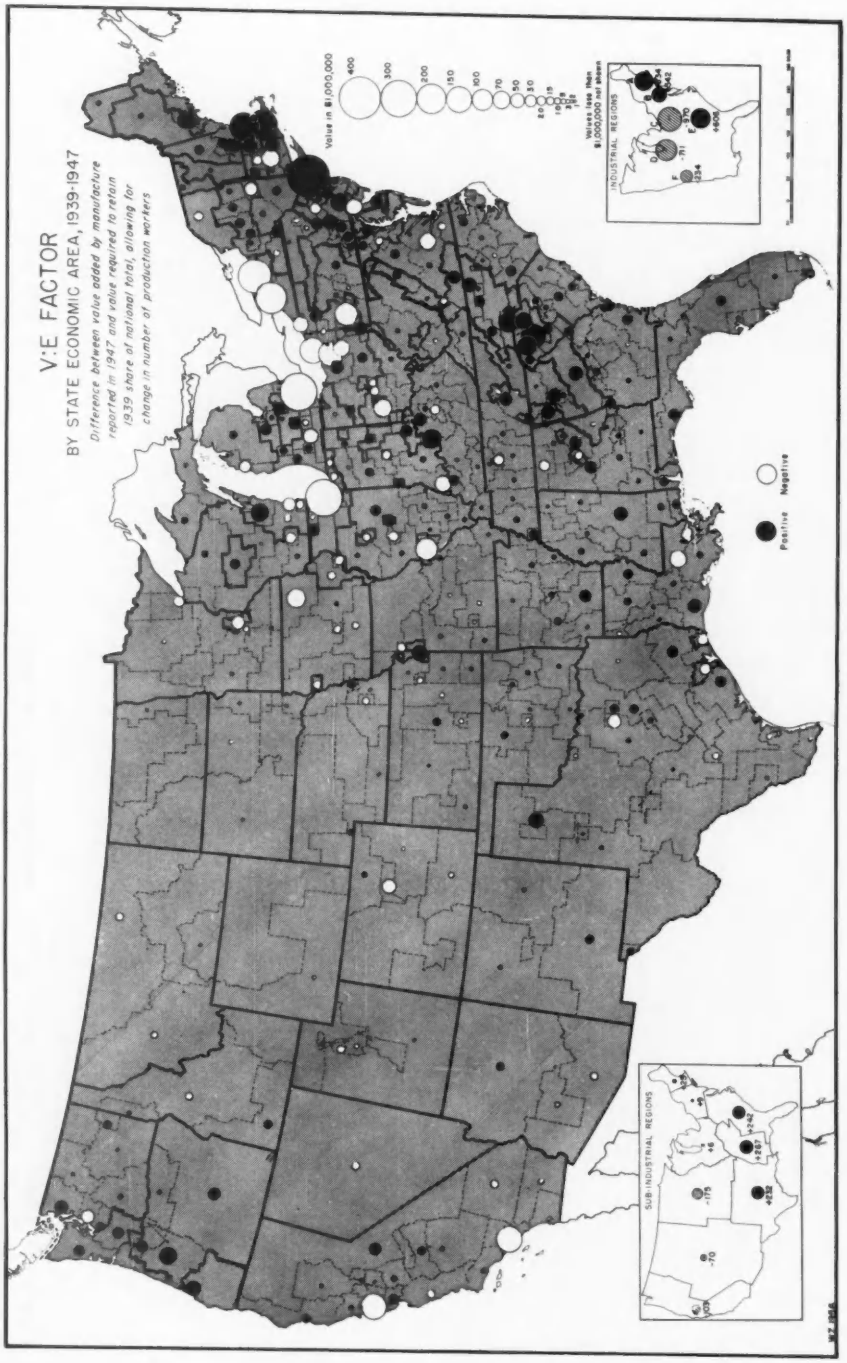

V:E FACTOR
BY STATE ECONOMIC AREA, 1939-1947
Difference between value added by manufacture reported in 1947 and value required to retain 1939 share of national total, allowing for change in number of production workers
Value in $1,000,000
400
300
200
150
100
70
50
30
20
15
10
5
3
1
Positive
Negative
INDUSTRIAL REGIONS
SUB-INDUSTRIAL REGIONS

FIG. 10.

relationships between two factors of a more complex character than that presented here,[30] or where the distributional change of the M item is to be measured against more than one P variable at the same time. In any event, it is apparent that the M:P factor offers one possible technique whereby the correlation in the areal distribution of two variables through time can be measured.

In answer to the question of why the constant k in the above formula does not correspond exactly to the quotient of the national ratios for the two years involved, the reader is invited to apply the M:P formula to a simple hypothetical situation for a nation consisting of three or four regions which undergo radical shifts in both manufacturing and population distribution. Although the arithmetic of the formula is such that k will only accidentally ever equal the quotient of the two national rates, in practice where many areal units are involved and the shifts are only moderate in extent—as has been the case with the material used here—then k will fall rather close to the ideal value. Thus the k value for the V:P factor for the United States, 1939–1947, turned out to be approximately 2.71 instead of the 2.76 obtained by dividing the 1947 per-capita value of $519 by the 1939 figure of $188; and k for the E:P factor was found to be about 1.34 instead of 1.38. It is necessary to arrive at k through a series of approximations until the sum of the provisional M:P factors equals zero.

Among the other undesirable arithmetic peculiarities of the M:P factor is the fact that it is non-additive both spatially and temporally. Consequently, in order to derive the aggregate V:P factor for the East Lakes industrial region, the formula must be applied to each of the component SEA's in turn and the results then added; it cannot be applied to data for the region as a whole, for the two procedures yield two significantly different results. Assuming the individual SEA's to be valid economic regions, while the larger industrial regions are patently heterogeneous, the former figure will be the more meaningful one. Similarly, if we must find the V:P factor for the East Lakes industrial region for the period 1929–1947, we must employ only 1929 and 1947 data. The addition of the M:P factors for the 1929–1939 and 1939–1947 periods, which are, of course, of considerable importance in themselves, will not produce the same value. It is problematical whether an equally good alternative formula can be devised which would avoid this annoying limitation.

[30] Arthur H. Robinson has recently evolved a technique for the study of the areal correlation of such pairs of factors at single points in time. This procedure is described in abstract form in "A Method for Expressing Quantitatively the Correspondence of Mapped Distributions," *Annals Assn. Amer. Geogrs.*, Vol. 46, 1956, pp. 270–271.

THE 1939–1947 PERIOD IN AMERICAN MANUFACTURING HISTORY

There is no avoiding the fact that the period covered in this study was in many ways the most extraordinary in the economic history of this nation. Both absolute and relative change in manufacturing activity were greater than anything previously experienced for a like period, owing to the tremendous demands of the war economy and an unusually active market for manufactured goods in the postwar years. Furthermore, in place of the relatively free play of the market place characteristic of our nation from its earliest days, the economy was subjected to close governmental supervision from about 1941 to 1945; and after the war federal regulation continued to assume a vastly greater role

in economic affairs than during the prewar era. Manufacturing output and the construction of new plants were particularly responsive to government edict, and it is an open question how much this circumstance has affected former locational trends, or in what direction, although it is undeniable that there has been some alteration of pattern. Neither is it clear what immediate geographic effects can be attributed to the unusually rapid rate of technical development enjoyed by American industry during these breathtaking years. Finally, the massive population movements of the 1939–1947 period rivaled and probably transcended anything previously occurring on a national level, even though such a statement is not readily validated in the present state of our migration statistics.

Earlier studies covering the years preceding 1939 have reached significantly different results because of differences in time span, sources and types of data, and methods for gauging manufacturing shifts; but the few trends unanimously noted are worth recalling:[31] (1) in spite of the magnitude of aggregate change in industrial activity and population distribution, the locational pattern of American manufactures has been remarkably stable since at least 1899; change has been slow and slight, and often indeterminate as to direction; (2) there has been a slow, but cumulatively important diffusion of industry into the peripheral zones of virtually all metropolitan areas; (3) there has been a less decided but still measurable dispersion of industrial activity out from the metropolitan areas into the surrounding, relatively unindustrialized regions, a trend most notable in the South Atlantic states; and (4) interregionally, there has been a certain relative outward movement of industry from the New England and Middle Atlantic states into the North Central, South Atlantic, and Pacific states, or, more generally, from north and east to south and west; but it is nowhere explicity stated in these earlier studies whether such movements have proceeded at rates less, equal to, or greater than some broadly comparable changes in population distribution that took place concurrently.

[31] These trends are well described in Woodbury, *op. cit.*, pp. 241–243.

THE V FACTOR

If we begin our review of the 1939–1947 data by studying the V factor (Fig. 5; Table II), our initial impression is one of a rather chaotic absence of pattern, with frequent sharp differences, in sign as well as magnitude, between neighboring SEA's. By scrutinizing the map inset and the regional tabulations, however, we detect these definite tendencies: (1) a shift away from all industrial regions, save the Southeastern, with particularly heavy losses in the New England and Middle Atlantic regions, the aggregate figure for the industrial category being –$1,836,000,000, or 3.6 per cent of its 1947 value added; (2) marked gains in several sub-industrial regions, among which the Pacific enjoys a healthy lead, while all three Southern regions and the East North Central also register strongly positive; (3) within the industrial category, large losses among the metropolitan SEA's as a class, whereas the non-metropolitan recorded significant gains, especially in the East Lakes and West Lakes regions; and (4) comparable results in the sub-industrial regions where the metropolitan SEA's experienced slight losses or gains far less than those characteristic of the non-metropolitan SEA's. All told, the metropolitan SEA's of the nation registered a V factor of –$1,668,000,000, or

3.0 per cent of the 1947 figure. The general conclusion from the summary V factor data, then, is that there was a moderate, but definite, dispersion from industrial to sub-industrial and from metropolitan to non-metropolitan areas. In only one region—the West North Central sub-industrial—did local trends run counter to the national pattern; and in the Southeastern industrial region, the other important exceptional area, strong gains among the numerous non-metropolitan SEA's lifted the entire region into positive status.

From the main portion of Figure 5 it seems obvious that within the Manufacturing Belt there is a negative correlation between size of metropolis and the V factor. Thus, the West Lakes region would have had a sizable positive total had it not been for the substantial losses in its two largest cities, Chicago and Detroit; and in the East Lakes region the largest cities all recorded negative values. The almost uniformly positive behavior of the Southeastern industrial SEA's is noteworthy, and so also the fact that in the sub-industrial East South Central and West South Central regions the negative results are rare and small outside New Orleans and Beaumont–Port Arthur, so that the pattern throughout these still relatively unindustrialized regions is one of widespread gain. Trends are mixed in the sub-industrial South Atlantic, Middle Atlantic, West North Central, and Mountain regions and have little impact on the national pattern.

THE P FACTOR

Before we consider the effects of "normalizing" the value-added data for population change through the medium of the V:P factor, it is worth while examining the relative locational shifts in population alone as expressed through the P factor (Fig. 7). Figure 7 shows the net regional movement during the study period to have been quite vigorous, with trends that are already familiar to most readers. Some appreciation of the magnitude of population change during this 8-year interval can be gained by noting that the algebraic sum of the P factor by SEA equals 13,520,000 persons, or 9.4 per cent of the national total in 1947. Phenomenal gains occurred in most areas within the Pacific and southern Mountain states, and there were substantial increases in the percentage of national population located in Florida and along the Gulf Coast. There were impressive gains in Washington, Baltimore, Detroit, and many other metropolitan areas, especially in southern Michigan, most of Ohio and Indiana, southern Connecticut, and most cities in the Southeast. Losses were rather general among most relatively non-urban areas and were particularly striking throughout the Mississippi–Missouri basin and in the Middle Atlantic and New England states. Within the latter groups of states, both metropolitan and non-metropolitan areas suffered loss or, at best, held stationary, except in Connecticut and southern New Jersey. A westward flow in population is evident within the Manufacturing Belt, where only the West Lakes region succeeded in raising its share of the national total.

THE V:P FACTOR

An analysis of the V:P factor (Fig. 8; Table II) reveals a set of decided differences from the V factor pattern.[32] Largely thanks to the improved showing of the Middle Atlantic industrial region, the aggregate V:P factor for the industrial category is

[32] In order to facilitate comparison, the scales of symbols on Figures 5, 6, 8, 9, and 10 have been made as nearly equivalent as the nature of the data permits.

reduced from –$1,836,000,000 to –$796,000,000, or only 1.6 per cent of 1947 value added; and there is, of course, a corresponding drop in the aggregate gain of the sub-industrial regions. On the other hand, the gap between the negative metropolitan and the positive non-metropolitan areas has been broadened considerably. Among the industrial regions, the East Lakes SEA's now achieve a positive total and the Southeastern region appreciably enhances its previously positive standing. New England's losses appear less drastic when the region's population trend is taken into account than they did in terms of the V factor. Indeed, several positive SEA's make their debut, notably, Providence–New Bedford–Pawtucket and Springfield. Even more dramatic is the transformation of the New York metropolitan area from a negative entity to the SEA with the greatest positive V:P factor in the nation. Within the West Lakes region there are positive gains on the part of all SEA's as compared to their V factor showing, except for Detroit, which not only retains its title as the SEA with the largest negative value but even doubles the former figure.[33] The West North Central sub-industrial region has a decidedly more positive cast on Figure 8 than previously observed, but the Southern sub-industrial regions remain much the same as before, except that Florida now falls definitely within the group of negative areas.

By all odds the greatest discrepancy between the two maps of locational shift in value added is found in the Pacific sub-industrial region. By adding population change to the reckoning, its +$729,000,000 V factor, largest among all regions, is reversed to a –$429,000,000 V:P factor, the greatest loss reported for any region. Clearly, then, the absolute gain in industrial activity in California, Oregon, and Washington, great though it may have been, failed by a wide margin to keep pace with population growth. Nevertheless, certain SEA's—Los Angeles and Portland, in particular—managed to retain positive status, even though with sharply diminished values; and this fact may well foreshadow future trends in the economic development of the region. Since they have attracted so much general attention, it is interesting to note that the Gulf Coast and Texas areas, which have experienced notable population gains and absolute increases in manufacturing activity, achieve only a mixed, though generally positive, showing in terms of the V:P factor. The New Orleans, Beaumont–Port Arthur, Houston, San Antonio, and Corpus Christi SEA's all register negatively or show no change, while Dallas, Fort Worth, Baton Rouge, and Galveston recorded relatively modest gains. This statement must be interpreted to mean that rapid industrial development has been hard put to it to keep abreast of a vigorous growth in population.

Summing up our comparison of the V and V:P factor patterns, it appears that industrial growth has not kept up with population increase in Florida or the Pacific Coast but has approximately paralleled population growth in Texas and the Gulf Coast. Within the Manufacturing Belt, industry has moved more rapidly westward in a statistical sense than has population from the New England and Middle Atlantic regions to the East Lakes and West Lakes, except in the case of anomalous Detroit. Within the sub-industrial regions, the central group (i.e., the north

[33] For reasons that are not immediately apparent, the Detroit SEA is the largest in the nation to register negatively in terms of all five indices of change; but it can be assumed that the automotive industry, with its often abrupt reversals in production rates, is the critical factor here.

central and south central states) have fared best. The relative regional shifts in manufacturing activity have, then, not only equalled but outstripped the westward and southward movement of population, at least up to the edge of the Great Plains and northern Florida.

THE E AND E:P FACTORS

The patterns of relative change in the distribution of production workers, as expressed through the E factor (Fig. 6; Table III) and the E:P factor (Fig. 9), bear only a broad resemblance to those for value added.[34] The trend within each major segment of the nation is relatively uniform and not nearly so chaotic as was observed for the V and V:P factors. As the map of the E factor is scrutinized, sharp regional contrasts appear at once, particularly between the Atlantic Seaboard, which is almost uniformly negative, and the Middle West, where the only even moderately important negative values occur at Wheeling, Detroit, and Pittsburgh. Within the sub-industrial regions, positive values predominate among the rather mixed results obtained for the North Central and South Central states, whereas the opposite holds true for the South Atlantic region. The urban centers of the Pacific states show up as decidedly positive, even though the non-metropolitan SEA's of the same region are largely negative.

[34] Among the more noteworthy studies of shifts in manufacturing employment are Frederic B. Garver, Francis M. Boddy, and Alvar J. Nixon: *The Location of Manufactures in the United States, 1899–1929*, University of Minnesota Employment Stabilization Research Institute, Minneapolis, 1933; Tracy E. Thompson, *op. cit.;* Daniel B. Creamer: *Is Industry Decentralizing?;* Harold D. Kube and Ralph H. Danhof: *Changes in Distribution of Manufacturing Wage Earners, 1899–1939*, Bureau of the Census and Bureau of Agricultural Economics, Washington, 1942; Marion Hayes, *op. cit.;* and Seymour L. Wolfbein: "Changing Geography of American Industry," *Monthly Labor Review*, Vol. 79, 1954, pp. 1–5.

Although the distributional pattern of the E:P factor retains the general configuration of the E factor, there is one major change. The Pacific Coast, again with the significant exception of the Los Angeles area, is metamorphosed from a positive to a negative region. The New York metropolitan area undergoes the reverse process, being transformed from an SEA with a large negative value to one of the most important gainers in terms of the E:P factor. Some mention must also be made of the augmented positive values in the Scranton, Wilkes-Barre, Hartford, and Springfield (Mass.) SEA's, since they stand out so glaringly from their emphatically negative neighbors. Viewed nationally, the most impressive aspect of the E factor is a strongly westward thrust from the acutely negative East Coast to the heavily positive Central and Far Western areas; and in the case of the E:P factor, there is an equally striking pattern of movement away from both the Atlantic and Pacific Coasts into the interior of the nation.

The distributional shifts among categories for the E and E:P factors are somewhat at variance with those noted for the V and V:P factors. On a national scale, the metropolitan SEA's gained workers at the expense of the non-metropolitan in terms of the E factor, but lost substantially when tallied in terms of the E:P factor. There was, however, the same pronounced movement from industrial to sub-industrial SEA's: a total of 220,000 workers (E factor) or 124,000 (E:P factor).

Even though this paper is limited to describing change, it seems apposite to comment on that fraction of distributional change which may be assigned to plant expansion or construction and the recruiting of workers from other segments of the economy. It appears likely that in the more heavily indus-

TABLE IV

CHANGE IN RELATIVE DISTRIBUTION OF VALUE ADDED PER PRODUCTION WORKER, 1939–1947

Region	Value Added by Manufacture per Production Worker (in dollars)						V:E Factor, 1939–1947 (in $1,000,000 and % of 1947 value)		
	1939			1947					
	Met	Non Met	Total	Met	Non Met	Total	Met	Non Met	Total
INDUSTRIAL REGIONS									
A. New England	2658	2066	2560	5617	5298	5573	+394 6.9	+139 15.1	+534 8.0
B. Middle Atlantic	3342	2342	3244	6790	4668	6632	+230 1.5	+112 9.6	+342 2.0
C. East Lakes	3674	2892	3539	6511	6044	6428	-1095 10.6	+124 6.4	-970 6.4
D. West Lakes	3709	3369	3659	6882	6441	6808	-711 5.9	-- --	-711 5.0
Manufacturing Belt	3387	2714	3296	6558	5719	6440	-1181 2.7	+376 6.1	-805 1.6
E. Southeastern	2434	1645	1917	5512	4391	4786	+120 9.2	+486 24.4	+606 18.6
F. Isolated Industrial SEA's	3952	2935	3817	7139	7349	7161	-349 8.3	+115 23.0	-234 4.9
Total Industrial	3394	2399	3215	6580	5419	6375	-1410 2.8	+977 11.4	-433 0.8
SUB-INDUSTRIAL REGIONS									
New England	2344	2000	2109	5350	4660	4895	+8 12.5	+16 14.3	+25 14.1
Middle Atlantic	2253	2615	2488	4181	5238	4827	-15 4.1	+24 3.4	+9 0.9
East North Central	4337	2637	2701	5665	5040	5066	-52 49.5	+58 3.6	+6 0.4
West North Central	3833	3058	3243	6581	5409	5734	-63 12.5	-112 10.3	-175 10.9
Northeast	2960	2725	2773	5330	5170	5206	-122 11.7	-13 0.4	-135 3.6
South Atlantic	2929	1816	2168	5821	4272	4810	+14 1.8	+228 16.7	+242 11.2
East South Central	2947	1637	1861	6266	4376	4706	+18 5.0	+249 20.7	+267 17.7
West South Central	3475	2231	2732	6676	5680	6120	-33 3.0	+265 22.7	+232 10.3
South	3149	1862	2249	6287	4714	5200	-1 --	+742 19.8	+741 12.4
Mountain	4190	3821	3920	6742	7567	7262	-67 21.9	-4 0.8	-70 8.4
Pacific	4027	2919	3783	7423	7477	7424	-290 6.7	+188 21.6	-103 2.0
West	4039	3235	3812	7366	7511	7405	-357 7.8	+184 13.1	-172 28.6
Total Sub-Industrial	3565	2372	2825	6710	5214	5842	-480 6.1	+913 10.5	+433 2.6
GRAND TOTAL	3414	2384	3130	6597	5314	6245	-1889 3.3	+1889 10.9	-- --

trialized areas, development has reached the stage where the basic requirements for industrial expansion—a substantial number of potential employees and a selection of suitable plant sites accessible to good supplies of water and other utilities and to adequate transport, and containing a sufficient extent of topographically acceptable terrain—are becoming more difficult to secure than in certain relatively unindustrialized areas. This "saturation effect" may well become more noticeable in the future after the existing supply of prime industrial sites approaches exhaustion and it becomes increasingly difficult to induce a large proportion of an occupationally upgraded population to accept production work in factories.

THE V:E FACTOR

The obvious discrepancies in pattern between the distributional shifts in value added and in number of production workers invite our inspection of the V:E factor, representing as it does the difference between both the V and E and the V:P and E:P factors (Fig. 10; Table IV). Table IV discloses the fact that, viewed in terms of the V:E factor, which is, to repeat, that portion of relative change in value added that can be ascribed to relative change in labor productivity, the broad categories of SEA's display a pattern similar to those previously observed for other factors. Once again a definite shift from industrial to sub-industrial and from metropolitan to non-metropolitan. From this fact we can conclude that the locational trends in value added are, in the broadest sense, the sum of parallel trends in both number of production workers and per-worker productivity. However, an examination of the individual SEA's or regions reveals a pronounced irregularity in their behavior. There are few SEA's which, like Detroit or Nashville, register negatively in terms of all five indices of change, or which have consistently positive values, like Kansas City or Galveston. Likewise, among all 15 regions, only the East North Central, East South Central, and West South Central sub-industrial regions behave uniformly (and positively) in the various tables herewith presented.

In its lack of resemblance to the preceding maps, Figure 10 illustrates the poor correlation of the various indices at the local level. Indeed, the distributional pattern of the V:E factor is, in its major lineaments, the inverse of that for the E and E:P factor: strong gains along the Atlantic Seaboard and heavy losses in the Great Lakes area. Among the sub-industrial regions, trends are indeterminate in the East North Central states, negative in the West North Central, and definitely positive in the Southern regions. The pattern along the Pacific Coast is curious—marked gains in Oregon and Washington, but major losses in the larger California metropolises. An analysis of Table IV suggests a simple explanation for all the foregoing trends: a decided evening out of regional differentials in productivity. Thus, the New England, Middle Atlantic, and Southeastern industrial regions and the Southern sub-industrial regions, all of which had relatively low rates in 1939, recorded the greatest progress by 1947; and the regions of high productivity—namely, the East Lakes, West Lakes, Mountain, and Pacific—all experienced relative losses.

CONCLUSIONS

To sum up the results of the preceding analysis, the following statements can be ventured on areal trends in American manufacturing during the

study period: (1) in spite of great quantitative changes in industrial activity and population distribution, the locational pattern of American manufactures continued to display much the same stability that has characterized it since at least 1899; (2) nevertheless, there has been a significant relative dispersion of industrial activity out from the metropolitan areas into the adjacent, relatively unindustrialized regions, from the eastern to the western portions of the Manufacturing Belt, and from the Manufacturing Belt in general to the outer reaches of the nation; (3) when population change is taken into account, the extent of this dispersion is greatly reduced, and for the far western and far southern parts of the nation generally cancelled; but the gains are still important in the western portions of the Manufacturing Belt and within the central sub-industrial regions; (4) there was a definite trend toward the evening out of differentials in intensity of industrial activity between regions and also between metropolitan and non-metropolitan areas; but it would be hazardous to advance these as long-term trends without an analysis of earlier data and the recently published 1954 data; (5) lacking such an extension of this study, we cannot say whether the trends herein described have been accelerated or retarded as compared to earlier periods; and (6) there are large discrepancies in the various areal trends on both the local and regional level as plotted according to the five indices utilized here; and such non-conformity of pattern would undoubtedly be compounded if any of a large variety of alternative indices were invoked. This last finding should sharpen our awareness of the great complexity of the economic phenomenon we term manufacturing and, hence, the great difficulties to be expected in attempting a full, rational explanation of the locational trends we have just outlined.

THE CHANGING PATTERN OF NORWEGIAN HYDRO-ELECTRIC DEVELOPMENT

Wm. Lindsay Raitt

Mr. Raitt of Aberdeen, Scotland, for several years has been interested in the geography of hydroelectric power development. He spent the year 1955–1956 on a Norwegian State Scholarship at the Geographical Institute of the University of Oslo.

IT seems surprising that Norway should see fit to construct a power station harnessing nuclear energy when it has the world's largest production of hydroelectricity per capita of population, and a utilization of its water power resources amounting to only 37.5 per cent of the total—4.3 million kw. out of 12.3 million (although 16 million has been given as the total).[1] It is, of course, a far-sighted project, for the time will come when Norway's requirement of electricity will outstrip the possible production within reach of the more heavily populated and industrialized areas. Research work and experience in nuclear power station operation are required as much in Norway as they are anywhere else.

At the same time, the utilization of the available resources of hydroelectricity is increasing in momentum. During the 1930–1940 period development was at a rate of 40,000 kw. per year. The war years saw an increase to 60,000 kw. per year, but this is small compared to the post-war rates of 140,000 kw. per year in the 1945–1950 period[2] and 258,000 kw. per year in the 1950–1955 period. The cause is the increasing industrial activity and the expansion of the electrification of the railway system, but most of all the greater use of electricity and electric appliances in Norwegian homes, some 96 per cent of which now have an electricity supply.[3] The effect has been a change in the type of producer of hydroelectricity, in the method of supplying the power to the consumer, in fact, in the whole geography of power in Norway. Because the nation depends on hydroelectricity for its industrial power, and so for much of its wealth, it is of value to note this change while it is actually in progress and to visualize the eventual results.

An account must, however, be primarily qualitative because the change is still in progress. The quantities concerned are subject to frequent alterations which make general statistics speedily out-of-date. The larger part of this article is, therefore, concerned with showing the shape of the change through the use of detailed examples, made possible by a temporary diminution of the processes of change in a limited region.

The southern part of Norway forms an area which is well-nigh unsurpassable as the perfect field for hydroelectric power production. It consists mainly of a plateau at a height of 3000 to 4000 feet above sea level. This has an undulating surface which is ideal for the storage of water in lakes and peat

[1] *Industries of Norway*, O. J. Adamson, edit., Oslo, 1952.

[2] From *Industries of Norway*.

[3] Norges Vassdrags- og Elektrisitetsvesen, Årsberetning, 1954–1955, p. 7.

bogs. In addition, in the hard-rock monadnocks left by the Pliocene peneplanation[4] it has altitudes of 6000 to 7000 feet carrying the ice caps and long-lasting snow banks which provide, through their summer melting, an addition to the water supply. Supplementing this advantage of an extensive high area is the steep fall in the water courses needed to give the water its energy. This, southern Norway possesses in the steep edges of the plateau to the west, and the deep incisions in the south and east by the glaciated valleys with their U-shaped cross-profiles and stepped long-profiles.

The natural advantage provided in this plateau has been realized from the first days of the production of electricity from water power. There was a rapid development by national, communal, and private owners in the last years of the nineteenth century and the first of the twentieth, not only of stations supplying the cities, towns, and farming communities, but also of stations built expressly for the supplying of the electro-chemical and electro-metallurgical industries, and, most of all, the wood-products industry. There were many small stations constructed to supply the isolated farming areas, the villages, and the lesser timber mills. These conformed very closely to the perfect plan for a hydroelectric scheme: a small power-house was built at the foot of a natural waterfall making use of all or a part of the flow from the drainage area above. Where it was a tributary stream, the site was usually the overhang where it met the main valley; where it was a main stream, the site was a rock step crossing the valley and breaking the river gradient. Large stations were built to supply the cities and big population agglomerations, and also the largest factories. For these more capital was usually available to cover the construction costs and the schemes had a more artificial form, with the streams being diverted to where they are of most use for man's purpose.

In this article, a datum year is taken at 1943, partly because this was the year of the change-over from the early type of constructions to the post-war type, and partly because this is the year for which the greatest amount of information is available.[5] In 1943, then, there were in operation 1818 power stations with a capacity of less than 1000 kw., i.e., small stations. In contrast, there were only 10 of the large stations, i.e., over 50,000 kw. capacity, but they contained 40 per cent of the total capacity. Four of these were designed solely for the supply of electro-chemical or electro-metallurgical industries, the remainder were primarily for the general public supply. Fifty-two and one-half per cent of the total capacity was contained in the 181 medium-sized stations, i.e., between 1000 kw. and 50,000 kw., 112 of which were designed for public supply.

The year 1956 has been chosen as the year for comparison although there is no summary of statistics available and there is still a large number of stations in the construction stage. A few sample surveys show that the figures for 1943 must be greatly altered and that in the course of the 13 years following 1956 they will be radically altered. The number of large stations has increased to 20, of which 13 are primarily for public supply and most of the other seven give a proportion of their capacity for that purpose. Five of the seven new public supply stations are for the market in southeastern Norway where much of the population is concentrated

[4] K. M. Strøm: "Geomorphology of Norway," *Geogr. Journ.*, Vol. 112, 1948.

[5] Norges Vassdrags- og Elektrisitetsvesen, "Utbygd Vannkraft i Norge," Oslo, 1946.

TABLE I

THE LARGEST POWER STATIONS CONTRIBUTING TO SAMKJØRINGEN

Name	*Date of opening*	*Capacity 1943 kw.*	*Capacity 1956 kw.*	*Capacity c.1960 kw.*	*Locality*
Kykkelsrud	1903	51,600	51,600	51,600	Glommen
Vemork	1911	140,400	140,400	140,400	Rjukan
Vamma	1915	75,000	100,000	100,000	Glommen
Såheim	1916	116,900	116,900	116,900	Rjukan
Rånåsfoss	1922	61,000	61,000	61,000	Glommen
Solbergfoss	1924	67,800	80,000	80,000	Glommen
Nore I	1928	188,563	210,000	210,000	Buskerud
Nore II	1947	.....	57,000	57,000	Buskerud
Mår	1949	.....	180,000	180,000	Rjukan
Åbjøra	1951	.....	82,500	82,500	Oppland
Hol I	1952	.....	168,000	220,000	Buskerud
Vinstra	1953	.....	150,000	200,000	Oppland
Hol III	1957	.....	.....	60,000	Buskerud
Hjartdøla	1958	.....	.....	100,000	Telemark
Øvre Vinstra	1960	.....	.....	130,000	Oppland
Tokke	1960(?)	.....	.....	400,000	Telemark
Sum	.....	701,200	1,397,400	2,189,400	.....

(see Table I). Thus for the scattered population areas in the south, west, and north the important emphasis is on the greatly increased number of medium-sized stations. The tendency now is to make these of as great a size as is permitted by the complete regulation of the catchment area.

The result is a great decline in the number of small power stations. This is not because they are any more uneconomical to operate than they were before 1943; it is just because their reason or cause of existence, the supplying of small isolated communities or industries, is being removed through the connection of these to a more widespread system supplied by the medium- and large-sized stations. Thus a more steady and reliable current is supplied than could be obtained from small stations depending on unregulated streams. This reduction in the number of small stations cannot be statistically verified at the moment, it is only assumed from the situation in eastern Norway where examination has shown a sufficiently great closure to reduce the national total. Indeed it is doubtful if it has yet taken place to so marked an extent in western and northern Norway. The future of the small West Coast stations is uncertain because of the difficulties of establishing a network of transmission lines across the varied relief of the region, but it is probable that the expansion of the number of larger stations there will reduce the number of small stations to some extent. In North Norway the distances between the communities is so great that having many small stations is probably more economical than having one or two large ones transmitting through a lengthy network.

This tendency to centralization, the most notable feature of the post-war geography of power in Norway, will be further amplified and illustrated by a consideration of the progress made in the supplying of three areas, one valley, the distribution region of one company, and the whole of eastern Norway. It has proved difficult to systematize the material available for the post-war developments principally because of the obstacle presented by the variety of units used in publishing information about power stations. I have tried to standardize all figures as the kilowatt capacity of the turbines in the stations

to give a measure of the water power. In addition there is so much construction taking place that, while the published information may be immediately out-of-date, there is often no published information at all. Several printed sources, interviews with officials, and personal observations have all been used, and, though conflicting information has sometimes resulted, it has not altered the general qualitative picture that has emerged.

A/L Nord Østerdal Kraftlag

The northern part of Hedmark County, lying where the high watershed of Norway approaches the Swedish border, is part of the great Norwegian plateau. At an altitude between 3000 and 4000 feet above sea level, it is cut into by deep valleys trending from northwest to southeast. The plateau (the vidda) lies mostly above the timberline, and it is only on the lower valley slopes and the valley floors that tree growth is sufficiently good to give rise to productive forests. There is a little agriculture here, though it is confined to small areas by altitude and low rainfall. But agriculture and forestry and their associated industries are supplemented by mining of the sulphur pyrites and metallic ores which are found in the northern part of the area. The population of about 17,000 is well spread out though there are a few nuclei along the railway and at the mines.

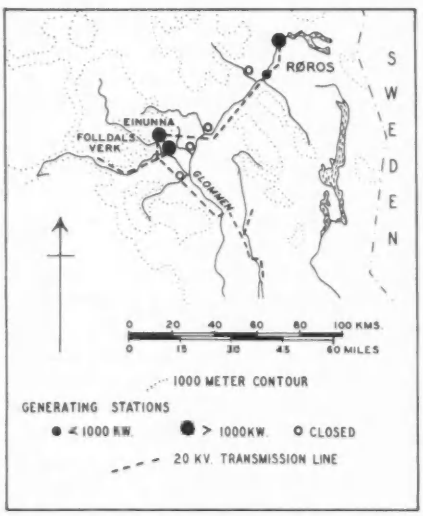


FIG. 1. Electricity supply in northern Hedmark (from N. V. E. Annual Report, 1954–1955).

This region obtained its public electricity supply from four generating stations whose total capacity was only 643 kw. Only a part of the population was supplied because of its dispersion, and the supply was variable because of the small machines used and unreliable because of the lack of an alternative source in the event of faults in the system. Three of the stations used a flow of water unregulated by reservoirs; the fourth had only a very small reservoir. The altered requirements of the post-1943 period made it necessary to change this state of affairs.

Therefore, a comprehensive company, A/L Nord Østerdal Kraftlag, was formed in 1944.[6] The solution adopted was typical of the post-war power planning, the centralization of production on one medium-sized power station, with a connection of the network to neighboring medium-sized stations. This solved the problems that had faced the previous suppliers in the following ways.

Contact was established with the two power producers, Røros Elektrisitetsverk and Folldal Verk A/S., who respectively supplied the mining population of the Røros district and the Folldal copper sulphate refinery. The purpose, and result, was cooperative operation (samkjøring) of the two power stations near Røros with a combined capacity of 2061 kw., with that at Folldal (Einunnufoss) with a capacity of 1620 kw.,

[6] Norges Vassdrags- og Elektrisitetsvesen, Årsberetning 1954–1955, pp. 43.

and the new station of A/L Nord Østerdal Kraftlag at Einunna, with a capacity initially of 4250 kVA., to be increased to 8500 kVA.[7] The interlinked transmission network (see Figure 1) would thus obviate a break in the supply if any one station should go out of operation. An interlinkage would also allow a deficit of current from one station due to inadequate water conditions to be made up from the water resources of the others.

The new power station was built one kilometer upstream on the same river as the Einunnufoss station of Folldal Verk A/S. Thus the new one benefits from the regulation already provided in the catchment area, and the new regulation, to be provided when the new station capacity is increased to 8500 kVA., will benefit the lower station. Then more water will be available to standardize the production throughout the year instead of having an excess in summer and a deficit in winter. Also, enough current will be available to give a supply to all the population in the region.

The advantages of concentration of production are thus apparent—better regulation to give a steady flow of water with increased reservoir storage resulting in a larger flow of water in the critical winter months when, owing to the consistently sub-freezing temperatures, the power stations run entirely on stored water; a more constant current given by the larger machines; and, through cooperation with other large stations, security against a break in the current due to the failure of some part of the machinery or to a depleted storage. Lastly, the constructing of a large station insures the production of enough current to supply all the local population without the necessity of additional stations. The four small stations continue at present to supply sections of the network, but they are to be closed down as soon as Einunna comes into full production. There are a number of other small stations in the area belonging to farms or factories. Verification has not been possible but it is probable that, in the light of the situation in Begnadalen, to be discussed next, several of these have been closed down with the widening of the scope of the general public supply.

[7] The capacity has not been published in kilowatts, but is probably of the order of 7500 to 8000 kw.

BEGNADALEN

A map of the distribution in southern Norway of the power stations of all sizes shows a concentration around the coastal fringe and a little way up the fjords and valleys. In the central area there are only two notable groups. One is in Vestfjorddalen, better known as Rjukan, where five of the largest stations in Norway supply electro-chemical factories. The other is a collection of stations spread out along Begnadalen, one of the great eastern valleys of Norway (see Figure 2 and Table II). The full interpretation of the localizing factors which have decided the siting of these stations must take cognizance of the geography of the valley, for these are closely allied.

The river Begna has its headwaters in the foothills of the Vest Jotunheim Mountains which surround the inner end of the largest of the west coast inlets, Sognefjord. From this gathering ground of high rainfall and melting snow and glaciers it flows southeastwards for a hundred miles across the high plateau, cutting into the 3000-foot surface in a narrow slot. It then combines with the river Randselv, and the combination flows over the fertile lowland of Ringerike to join Tyrifjord with its outlet by the Dramselv to the Oslofjord.

TABLE II

POWER STATIONS IN BEGNADALEN

No.	*Name*	*Date of opening*	*Capacity 1943 kw.*	*Capacity 1956 kw.*	*Comments*
1	Hønefoss	1881	6,918	10,230	Enlarged
2	Nedre Hofsfoss	1873	6,384	6,384	.....
3	Hofs Brug	1881	1,833	2,238	Enlarged
4	Hofsfoss	1872	1,791	1,791	.....
5	Svinefoss	1889	1,740	5,400	Enlarged
6	Nedre Hensfoss	1882	2,723	14,000	Enlarged
7	Øvre Hensfoss	1882	940	.....	Closed 1952
8	Amundfoss	1912	110	110	.....
9	A/L Busuelvens Verk	1914	30	.....	Closed 1955
10	Høgfoss el. verk	1916	110	.....	Closed 1952
11	Dalengbekkens el. verk	1914	73	73	.....
12	A/S Storbekkens Lysverk	1917	22	.....	Closed 1955
13	Langevassbekk el. verk	1911	22	22	.....
14	Olmhusfallet	1925	52	.....	Closed 1952
15	Trond Islandsmoen	1931	6	.....	Closed 1953
16	A/S Bagn Lysanlegg	1912	37	.....	Closed 1952
17	Storbrufoss	1909	1,605	2,300	Enlarged
18	Houg	1944	.....	17	.....
19	Kvål og Bøen	1936	8	8	.....
20	Skinnerud	1944	.....	6	.....
21	A/L Reinli Lysverk	1915	18	.....	Closed 1952
22	Alunfoss el. verk	1946	.....	.....	Closed 1951
23	Åmot	1946	.....	.....	Closed 1951
24	Klossbøle gård	1944	.....	.....	Closed 1952
25	Kvål el. verk	1925	18	18	.....
26	A/S Sørskogen el. verk	1915	48	48	.....
27	Åbjøra	1951	.....	81,600	.....
28	Åbjøra lysverk	1918	60	.....	Closed 1953
29	Vestrebø	1916	40	.....	Closed 1953
30	Nordåker Gård	1916	48	48	.....
31	Faslefoss III	1947	.....	1,120	.....
32	Faslefoss II	1939	1,100	2,850	Enlarged
33	Faslefoss I	1933	350	.....	Closed (?)
34	Faslefoss prov.	1926	147	.....	Closed 1947
35	Leira	1914	37	.....	Closed 1955
36	Fosheim	1921	147	147	.....
37	Hamarsta	1918	52	52	.....
38	Øye	1941	120	120	.....
39	Eidsfoss	1924	110	2,208	Enlarged
40	Ylja	1941	644	644	.....
41	Kvitvella	1924	180	180	.....
42	Holdalsfoss	1949	.....	22	.....
43	Linderud	1938	5	.....	Closed 1952
44	Nedrefoss mølle	1940	88	88	.....
45	Storefoss	1907	160	160	.....
46	Nordtorp Gård	1919	25	25	.....
47	Skoltefoss	1927	630	630	.....
Totals:	.....	....	28,461	132,599	.....

At the confluence with the Randselv lies the town of Hønefoss. This is the focus of a number of valley routeways, as well as marking the point where the Oslo to Bergen railway touches the well-populated Ringerike region. Its population, now about 6000, is based on several light engineering works, a big brewery, and paper mills. The power for this industry comes from a station situated on the waterfall, Hønefoss, which the Begna crosses just before it joins the Randselv. This power station supplies the domestic needs of the town, and also the electricity used in the farms of Ringerike.

Upstream from Hønefoss are a number of other rock steps in the river profile, and the waterfalls are the sites of six power stations. In 1943, these were each attached to a papermill or a sawmill. A large part of the middle Begnadalen is devoted to forestry, and all spring and summer the river provides

the means of transport for the cut logs. These are processed at the factories in the lowest part of the river valley, and it is a fortunate chance that also available there is the water power necessary to drive the machinery. These power stations, that of Hønefoss and the six of the timber mills, were constructed between the years 1872 and 1889.

There is a space in the distribution of stations in the region where the valley narrows to a strip occupied by the lake Sperillen. There are only a few scattered settlements along the shores, small farms and foresters' homes. At the upper end of the lake is the village of Nes, and the Begna Valley and its tributary valley are floored here with wide flat terraces supporting a few large farms as well as much productive forest. A power station was required to supply the village and farms and it was sited on the tributary river which, conveniently near, has a quite considerable fall over a rock step, the Amundfoss. In the upper part of this side valley is a surprisingly large collection of farms, Hedal, where, at an altitude of over 1500 feet above the sea, the prosperous agricultural settlement supports several hundred persons. A small stream falling down the valley side provided a site for a power station of sufficient size to meet the needs of the farms.

Returning to the main valley, there are a number of settlement nuclei as well as scattered farms on the valley floor from the head of Lake Sperillen northwest to Bagn. There is correspondingly a string of power stations of small size sited on the streams and tributary rivers which come down the valley sides from the flat plateau above. These have heads (i.e., utilized falls) of 160, 490, 476, 490, and 68.5 feet, which are relatively considerable, the larger ones being typical of the little tributary streams that have not cut overhanging valleys.

At Bagn the valley opens out into a deep basin-shaped hollow. Here the Begna is joined by the tributary river

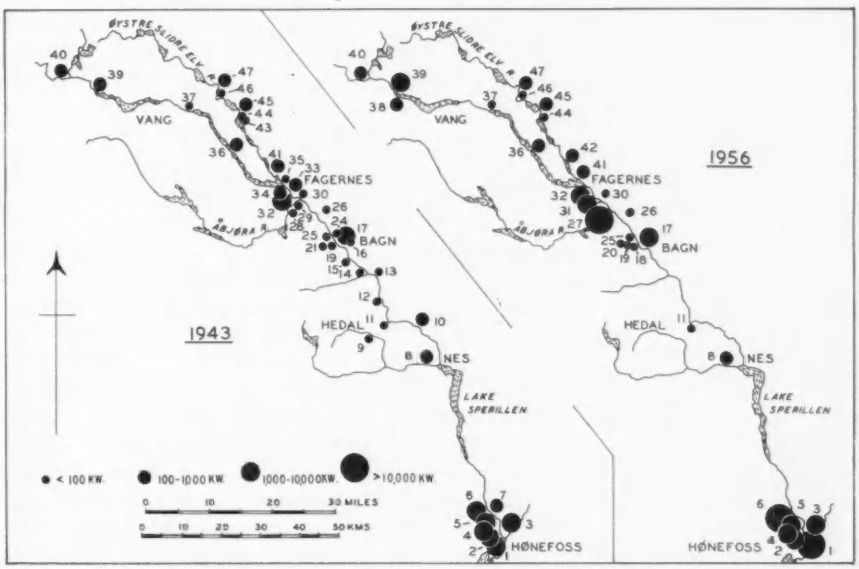


FIG. 2. Generating stations in Begnadalen (numbers refer to Table II).

Reina, which, though it runs in a deep valley itself, overhangs the main one by fully 1300 feet. The falls that the Reina crosses in its descent have been used by a few sawmills. The Reina's catchment area is not large, so that it does not provide sufficient water for any really large stations, but the type of its fall is well suited to producing power for the small mills. The valley of the Begna itself undergoes a transformation at Bagn. Upstream it is wide and flat-floored, though still steep-sided. The floor of the Bagn basin lies 260 feet below this flat-floored section. The river has made the descent first by cutting a deep gorge and then plunging the last 52 feet straight over a rock fall. This last part has given the site for the Storbrufoss station which, in 1943, was incorporated in a large sawmill, using most of the power by direct transmission (see Figure 6). The general supply to the village and to the farms in the basin came from one of the little streams cascading down the valley side.

The next concentration of stations occurs below Fagernes, where two valleys from the northwest combine in the lake Strandefjord which is separated by a rock step from the flat-floored section leading to Bagn. With the advantage of the lake above to provide a reservoir, the fall of the Begna over this step, the Faslefoss, was an obvious power site (see Figure 7). Yet it was not until 1933 that the requirements of the area led to a sizable generating station being constructed on it. However, from that year, and again from 1939, when a second, larger station was opened, the power of the falling water was transformed to electricity. The demand that eventually caused the building of these stations, and which had led to the constructing of a number of small stations on the tributary streams coming down the valley sides, came from the large population settled in and round the town of Fagernes.

The Fagernes area marks the division between the two sections of the valley known as the "forest" region (skogbygder) and the "mountain" region (fjellbygder). This division, found in all the eastern valleys, is quite distinct in Begnadalen. To the south the main occupation is forestry, and the valley floor and sides and most of the plateau surface above are forested. To the north the principal occupation is farming though the forests in patches on the valley sides and in depressions in the high plateau provide employment for a part of the population. The town of Fagernes, as well as being the southern limit of the farming area, and at the junction of two big valleys, is the terminus of a railway to Oslo. Thus it has important marketing functions as well as small industries. The harnessing of Faslefoss provided for all the needs of this community.

Near Faslefoss the valley of Åbjøra meets Begnadalen, and the river joins the Begna after a series of steep rapids and falls. The potential power of this river is very great, but in 1943 it was harnessed only by two small stations, sufficient to supply the farms scattered over the steep but fertile slopes at the sides of the overhang of Åbjøra's valley. The chief reason for this was that there was no demand for a great quantity of power within Begnadalen.

Lastly, in the "mountain" region of farming lands, the power stations are well spaced out both in Begnadalen and its tributary, the Øystre Slidreelv Valley. The location of sawmills has had a certain amount of control on the siting of some of them, but the principal function has been the supply of the concentrations of settlements where some valley feature permits the population to gain a livelihood. The station Ylja

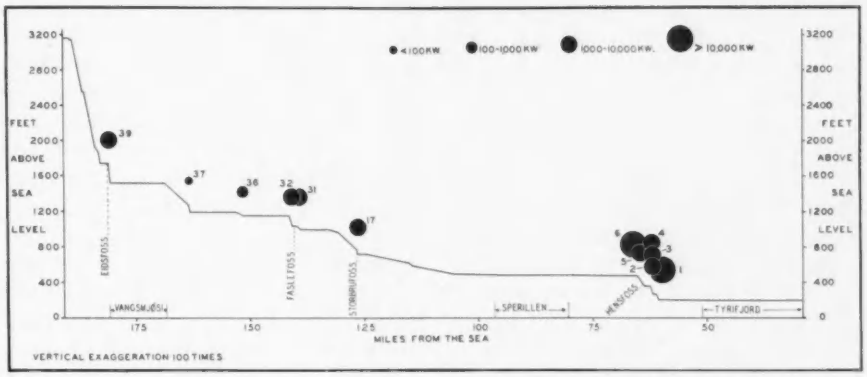


FIG. 3. River Begna—longitudinal profile and generating stations (numbers refer to Table II).

lies near the limit of settlement, and above the limit of cultivation, but its electricity is conducted down the valley to the Vang farming area, and also to some extent across the watershed to the settlements in the short Laerdalen Valley descending to Sognefjord.

It is clear that the situation and type of the power stations is very closely connected to the geography of the valley—the physical geography giving the power potentialities, and the human geography giving the demand for the electricity and controlling the economics of its development. The picture presented by the distribution and size of the power stations in 1956 is different from that of 1943, but there is still the same close correlation with geography.

The change to be noted in the lower valley takes the form of an expansion and a reorganization. Prosperity in the Hønefoss industries has increased their demand for electricity. Reflecting that of the industries is the relative prosperity of the labor supply, the people of Hønefoss, so there is a larger use of electricity in the homes as well as in the factories. To provide for it there has been an expansion of the Hønefoss power station. Its capacity was increased in 1947 by a third producing unit equal in size to each of the two existing ones. A fourth unit is to be installed towards the end of 1957, thereby doubling the size of the station in the space of ten years. To make up the deficit until the fourth machine is operating, the owning company has to depend on co-operative operation with the Samkjøringen organization, which transfers current from one of the other sources in the eastern Norway network.

The paper-making company which owns the Nedre Hofsfoss mill, A/S Follum Fabrikker, has expanded greatly by taking over three of the neighboring companies. Their mills have been closed down, but the hydroelectric stations have been completely rebuilt with much-increased capacities. The current is conveyed to the Nedre Hofsfoss paper mill which has been expanded in conjunction with the power available. The total capacity of the four stations has been doubled while a fifth, the smallest in this section of the valley, has been closed down so that its water supply could be put to more effective use in the more modern plant on the same fall. Therefore, the change to be recorded for this part of Begnadalen, corresponding to a greater demand for current in the local industries and

homes, consists of an extension of the capacity and a modernization of the equipment which was installed over 50 years before.

The main changes in the upper valley are to be seen as the consequences of the full utilization of the potentialities of the river Åbjøra. There is a gently-rolling region of the high peneplane bordering the prominent Hemsedal Mountains. The Åbjøra has its headstreams in the corries of the mountains, and crosses the plain through a series of large lakes, to drop steeply down 1300 feet to the Begna. The mountains have a high rainfall which, together with their snowfall, provides a good source for the river. The lakes require little artificial construction to make them into excellent reservoirs, and the fall into the main valley gives energy to this water volume. The site, then, is ideal for power production, and the Åbjøra station was one of the five large ones constructed in eastern Norway to provide for the heavy post-war demand (see Table I). As its capacity is 81,600 kw., it supplies not just the increased demand in Begnadalen; the greater part of its production goes through the transmission network of the Samkjøringen organization common to all eastern Norway, to provide for the areas with insufficient resources to meet their own markets (see Figures 4 and 5). The biggest consumer of Åbjøra's produce is the flourishing town of Gjøvik on the shore of Lake Mjøsen, to the east of Begnadalen. If there is an excess over the Gjøvik requirements the power may go to some other part of the network, for example to the city of Hamar, on the opposite side of Mjøsen, to Rjukan for the electro-chemical factories or to Hønefoss to supply the demand noted previously. However, the first demand to be met is that from Begnadalen.

The continuous distribution network extends up the valley to Vang and down it to Nes, and across the hills to Hedal. Thus an adequate, steady current is available anywhere in the middle parts of the valley. The result, as is brought out in the map (Fig. 2), has been the closure of many of the small stations which had been supplying a current that was far from adequate and very unsteady. Yet the picture it presents is not so clear as the scope of the change should indicate for the following three reasons.

1. One or two of the small stations directly attached to farms or small sawmills are sufficient to supply their own needs (often very seasonal). Such is the concentration of stations at Bagn, where the general domestic supply now comes from Åbjøra. The big Storbrufoss station has been entirely converted to electricity production and has its output transmitted to the sawmill which was transferred from the riverside to the plateau above, where the railway crosses from Begnadalen to Etnedalen. The locating factor is the cost of removing the product, and this is found to be least by rail. The power is transmittable and the raw material is in the immediate surroundings of the mill or can be brought to it by the railway. The valley from Fagernes to Lake Sperillen, despite the number of power stations still operating now, has its public supply from Åbjøra, with the exception of the village of Nord Aurdal, to be noted below, and the village of Nes which continues to be supplied from its own Amundfoss station.

2. The farms of the Vang-Fagernes section are supplied by current from A/S Faslefoss Elektrisitetsverk. The Faslefoss II station was closed down and replaced by a much larger one on a different site on some rapids below the main fall. The two stations operating at present provide the power required

by the Vang-Fagernes section of Begnadalen, by the lower Øystre Slidreelv Valley (the upper part being adequately provided for by Skoltefoss and Storefoss), by the village of Nord Aurdal, and by the town of Fagernes. The village of Nord Aurdal has always been supplied by A/S Faslefoss Elektrisitetsverk, while its neighbor, Leira, had its own small station on a side stream. Nord Aurdal, then, continues to be supplied by the enlarged Faslefoss group, but the small Leira station has had to close down, having proved inadequate to meet the needs of the village and consequently unable to compete with the introduced power from Åbjøra.

3. The uppermost section of the valley produces enough power for its own requirements. The Eidsfoss station has been expanded to twenty times its former capacity, while the station of Øye was only built in 1941, and, therefore, is in good order. Consequently, these two can supply all the demands of the Vang area except during the winter, when the water flow is greatly reduced by the freezing of the reservoirs and rivers, and then they are assisted by the Ylja station, whose reservoirs have been building up all summer when no water was released from them.

This covers all the stations in the valley, accounting for the changes that have taken place. It is noteworthy that previous to the year in which Åbjøra was opened, 1951, the only stations to close down were two of the Faslefoss stations, this being solely due to their replacement by Faslefoss III. After 1951, in the space of three years, eleven small stations had ceased to operate. This is the first change to be noted, a concentration of the production. The second change concerns the demand, for the population of the valley has had a greatly increased domestic use of electricity, leading to the necessity for a bigger production capacity. Thirdly, there has been an extension of the medium-sized stations as a response to this increased domestic use and to the prosperity of the industry in the lower valley. The changes in Begnadalen must be duplicated in other of the Eastern valleys, to a similar extent, though probably differing in the details of the process. On this basis it can be supposed that the accumulated statistics of the number and size of power stations for Norway must differ considerably in 1956 from those of 1943.

SAMKJØRINGEN

In the section of this article dealing with A/L Nord Østerdal Kraftlag the advantages of co-operation between a number of power suppliers in the operation of their stations were noted. The major organization at present existing in Norway for this co-operative operation is called Samkjøringen. It has a wide field of activity (see Figures 4 and 5), consisting in June, 1955, of 42 member companies, both producing and marketing. The area over which their activities extend, Østlandet, has a population of about 1,630,000. It has a central, well-populated core in the counties of Vestfold, Østfold, and Akershus including Oslo, the capital city, with a population of about 450,000, surrounded by the upland and valley counties of Telemark, Buskerud, and all but the most northerly parts of Oppland and Hedmark. There are, of course, very many companies within this area which do not participate in Samkjøringen, but it is noticeable that all the largest, producing and marketing, have seen fit to take part. They supply their consumers from some 80 power stations with a capacity in June, 1955, totalling 1,775,000 kw.,[8] an average of over 22,000 kw. per station,

[8] Samkjøringen, Årsberetning 1954–1955, p. 3.

which is considerably greater than the average of 2050 kw. per station of the total number of stations in Østlandet in 1943. This greater magnitude is due to the fact that it is primarily the large stations which are involved, but also to some extent to the fact that there has been an increase in the size of many of the existing stations and the new construction has been mainly of larger-sized stations.

Before going further into the change in the geography of hydroelectricity in Østlandet in connection with Samkjøringen, it is necessary to recapitulate the theoretical advantages to be gained by such co-operation.

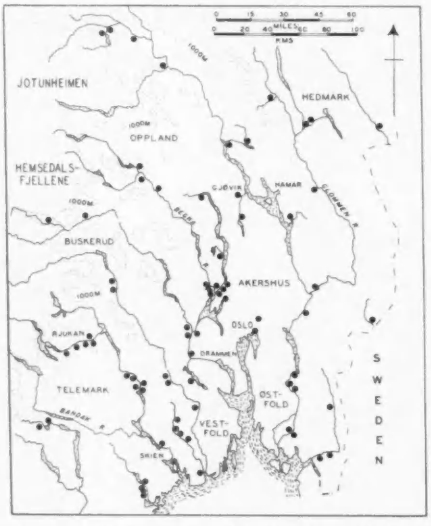
1. A permanent excess of water power resources in any area, either in the water supply or in the altitudinal differences, can be utilized and the current transferred to an area where there is a permanent deficiency.

2. There is no necessity to construct a station to contain stand-by plant, for, in case of a failure in the machinery, the supply can be restored by increased production from the other stations in the system.

3. The constructing of new stations will no longer be controlled by a purely local market. Instead of several small stations to supply small demands, one large one will be able to serve all the needs, and in a more reliable way.

4. Temporary excesses and deficiencies in the water supplies can be equalized by transferring the output from one part of the controlled region to another. Thus the water supply over the whole area is used as economically as possible and the current is equalized from day to day and season to season in harmony with the demands of the consumers.

5. With the alternative sources of power available, the number of breakdowns in the supply is reduced to a minimum, as is the duration of the breaks since they can be covered almost



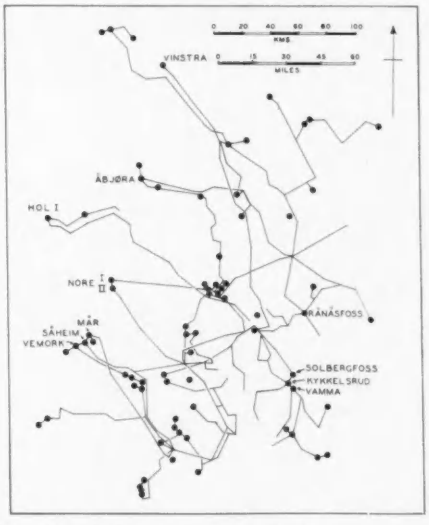


FIG. 4 (left). Generating stations contributing to Samkjøringen (from Samkjøringen Annual Report 1954–1955).

FIG. 5 (right). Transmission network of Samkjøringen (from Samkjøringen Annual Report, 1954–1955).

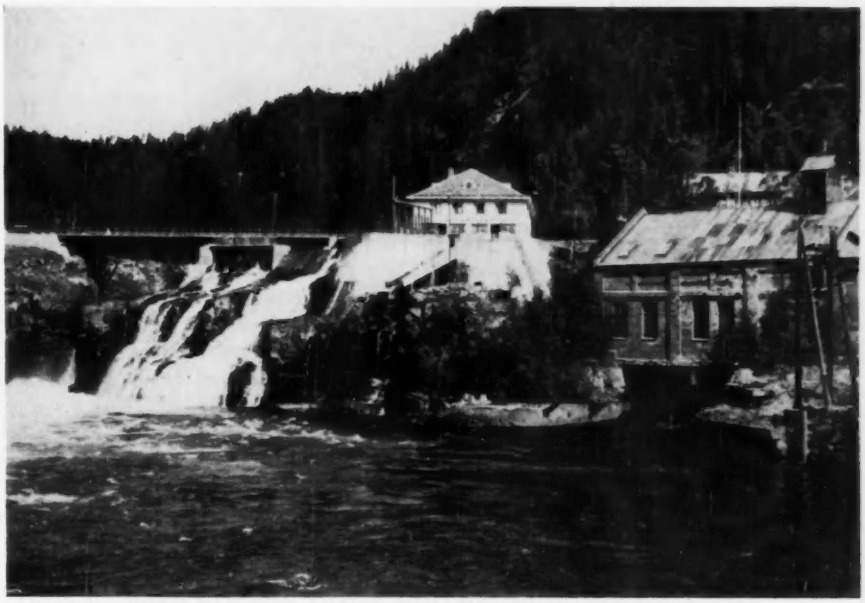


FIG. 6. The Storbrufoss generating station. The main waterfall is into the gorge underneath the bridge.

immediately by increased production from the other sources.

The ways in which Samkjøringen puts these advantages to practical use are many and varied in detail. It is proposed to deal here with only three of the most important—the benefits of the widespread network, the type of power station being built to serve it, and the future export of electricity which is dependent on it, noting their effect on geography in Østlandet.

Firstly, important effects on the supply of the electric current can be attributed to the scope of the network—the system of links between the power stations and the markets. The two largest consumers of power in Østlandet are the city of Oslo and the industrial center of Rjukan in Telemark. Oslo is to a certain extent an industrial city, but most of the factories get their power from their own private sources, the most important of which are on the two rivers, Akerselv and Loelv, running through the city. Thus the market supplied here by Samkjøringen is primarily domestic: the homes, the public buildings, the offices of the capital city of Norway, etc. The principal uses of the electricity must, therefore, be the lighting and heating of a city of some 450,000 inhabitants. In winter, because of the northerly latitude, there is only a short period of daylight, and this light is not very strong because of the low elevation of the sun above the horizon. A lot of electricity is, therefore, consumed in lighting, while in summer the opposite is true, for then there are very nearly 24 hours of daylight. Nearly all the post-war house building in Oslo has incorporated central heating using electricity as fuel. With temperatures far below freezing point lasting all day for two or three months in winter, it

is obvious that there is a much larger demand for heating as well as lighting. Taking it all together, on an average winter's day the consumption of electricity may be as much as five times that of an average summer's day.

In contrast, the demand for electricity by the factories of Rjukan is almost constant all the year, the amount required in the industrial processes overshadowing any variation in the quantity used in lighting and heating in the factories and in the town of Rjukan. Both these markets are connected by Samkjøringen, and they are balanced in the following manner.

During the winter, when the water supply is smallest and the overall demand is largest, all the stations are run at their maximum capacity. Rjukan takes all the power from the local stations because the factories were built of a size scaled to the amount of power available in winter. Oslo, likewise, takes up all the electricity of the stations which were built primarily to supply its needs, Solbergfoss, Vinstra, Hol I, and part of the production from Nore I and II. During the summer the demand from Oslo is very small, and its stations can be run on a part of their capacity so that much of the summer rainfall can be stored in the reservoirs to increase the winter flow. The Rjukan consumption is the same as in winter, but since some power can now be transferred from the Oslo group extra to what Oslo requires and to what can be stored as water in the reservoirs, the Rjukan stations can operate at only a part of their capacity, so that water can be stored in their reservoirs for the winter. In this way, the amount of energy stored as water in the reservoirs is greater than would otherwise be possible, and consequently the output needed in the vital winter months can be supplied without building more stations

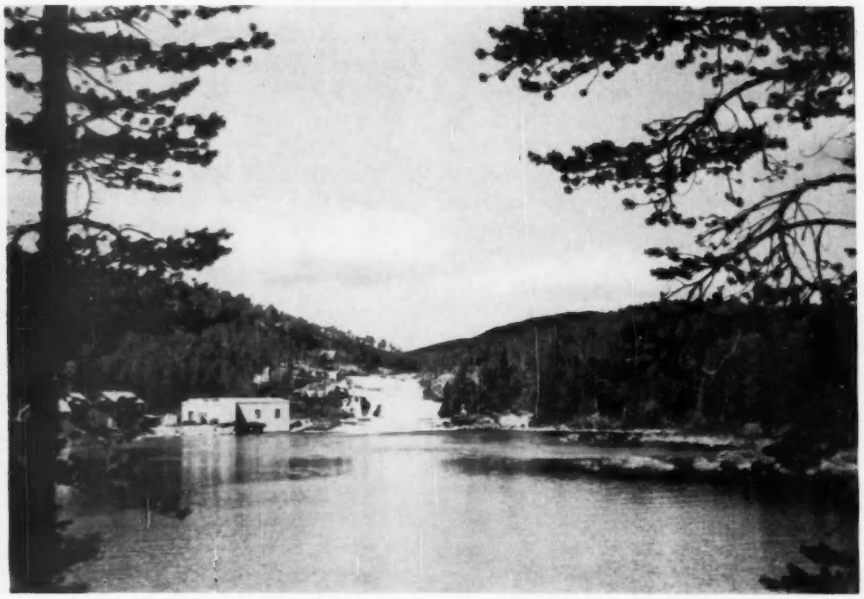


FIG. 7. Faslefoss, with the generating station Faslefoss II on the left. The old station Falsefoss I was on the right of the foot of the fall.

than is absolutely necessary, while the demand on the individual stations is spread out much more evenly over the whole year.

This function of Samkjøringen is, however, not just a way of profiting from the advantages offered by such an organization, it is a necessary contribution to the electricity supply system of Østlandet. On an average day in January twice as much capacity is required to satisfy the whole Samkjøringen network as on an average day in July, when there is so much more power available from the summer rains. Having run the stations entirely on the reservoir storage from November, by the beginning of May, notwithstanding the snow-melt, the amount of water flowing through the power stations is at a minimum. By the seventh of May in 1955 the content of the reservoirs supplying Åbjøra was reduced to 0.6 per cent of the total storage capacity.[9] It then requires the summer rainfall to build up the reservoirs again. It is, however, the case that not all the water can be stored and in the summer months a considerable amount by-passes the power stations whose size is controlled by the winter flow. But this water is of great importance to the Norwegian economy, as it is needed for the floating of the timber from the producing forests down the valleys to the timber mills, and in contributing to the scenic attractions it helps the tourist trade. With such conditions prevailing it is extremely important to have some kind of co-operative system working in Østlandet to even out the variations in the demands and supplies.

The potential water resources vary greatly over such a large region, and this sheds some light on the distribution and the sizes of the various power stations. The highest rainfall totals occur in the west, on the undulating upland of Hardangervidda. Thus the water supply in Telemark and Buskerud Counties is quite large. The power sites also are plentiful there owing to the dissection of the plateau by deep valleys crossed by rock steps. Most of the county of Telemark is included in the catchment basin of the Skien River which has the largest potential power of any one river catchment in Norway. It includes the Rjukan area with its five big stations of a capacity of almost 450,000 kw., soon to be increased by a further 35,000 kw., and the Bandak Valley whose resources are to be used in the new Tokke station of 400,000 kw., to be supplemented later by a second station of 350,000 kw. The rest of the western area comes within the catchments of the Numedalslågan and Dramselv, each of which has a very great potential of power, and, therefore, can support many high-capacity power stations.

The regions over towards the Swedish border lie in the rain-shadow of the mountains in the west. Therefore the tendency is to have much smaller stations. Here, too, the relief is less varied so that the potential sites are fewer. It is only where the Glommen, the principal river, has passed through a catchment basin of very great size that the power stations can be of a large capacity. This is in the county of Østfold, in the southeast of Norway, where the relief differences are almost negligible, and it is only the presence of small rock steps across the river course that provide sites for hydroelectric development. The average fall of water used in the six large lower Glommen stations is only 65 feet, whereas 60 per cent of the Norwegian resources are said to have falls of over 1000 feet.[10] It is only the great

[9] Samkjøringen, Årsberetning 1954–1955, p. 19.

[10] *The Norway Year Book, 1954*, Oslo, 1954.

amount of water carried by this river that has given Østfold any sizable source of water power.

The combination of high rainfall and high altitudinal differences give plentiful power resources in the west of Østlandet and low rainfall and small variety in the relief lead to small resources in the east. To equalize this situation—for the population and the demand is equally shared between the western and eastern parts—Samkjøringen has a network covering east and west Østlandet (see Figure 5). As each of the member-companies joined in the organization its own particular network for the distribution of the current from the main transmission lines was connected to the general system which has made possible the movement of current to where it is most required.

The second illustration of the value of Samkjøringen concerns the building of new stations. The demand for electricity in Østlandet is far from satisfied; indeed, there is a rationing of the current which operates in winter. Therefore, a company wishing to build a new station to supply a purely local need has the incentive to construct a much bigger station to help supply a much wider market. A larger station will require more extensive regulation and larger machinery which will help to give a better supply to the local market. The average size of the 28 new stations which were in the planning stage in July, 1955, within the Samkjøringen region was 58,400 kw., although if the three largest ones are excluded the average falls to 29,200 kw.[11] The amount of capital required for such projects is very great and it is noticeable that of the 13 of these projected power schemes over 30,000 kw. in capacity, nine are to be built by the State and the city of Oslo, though with some of the capital provided by local interests. Three are to be owned by the larger local authorities, and only one is to be built by an industrial company, the Mael station at Rjukan, belonging to Norsk Hydro. The trend in building is thus apparent—few and large stations, linked by a transmission network so that use can be made of the advantages of having large stations that were mentioned above. A direct consequence of this is that the need for smaller-sized stations is obviated by the wide coverage given by the Samkjøringen network. The situation has been noted already in the section on Begnadalen, but for any larger field considered there is as yet no published material.

The third illustration concerns a much wider sphere. It is obvious that the storage available in the lake basins cannot hold all the summer rainfall which is not required in the producing stations. Some water is running away unused, so despite the overall shortage and rationing of power there is actually a surplus in the summer. The suggestion which has been made is that this excess power should be exported to Sweden and Denmark where it could be put to use, either to save the use of coal in electricity production, or in increased industrial consumption in summer, or, in the case of Sweden, in allowing more of the summer rainfall there to be stored in the reservoirs for the Swedish hydro-electric stations. An export is, however, only made possible by the institution of a network of transmission lines which would serve first Norway's own needs, balancing the various requirements of the different producing and marketing regions. Samkjøringen already has completed the most important part of this network, covering the area of most concentrated requirements. Thus as well as contributing to Norway's exports by

[11] Samkjøringen, Årsberetning 1954–1955, p. 74.

supplying a constant electric current in large quantities for industrial purposes, it is possible that in the future Samkjøringen will contribute to Norway's export of the electricity itself—a raw material export, but one which at present is being wasted. In this way Samkjøringen takes part not only in a change in the geography of hydroelectricity in Norway, but in a change in the whole economic geography of Norway.

CONCLUSION

The study of hydroelectricity—the resources, the development and the market—corresponds closely to the ideal picture of geography, the interaction of man and the natural world. The physique of the earth's surface plays an important part because of its control of the potentialities of an area for production. The human world enters in two ways—through economics, for that decides what the nature and the magnitude of the development is to be; and through social geography, for that decides the market which will take the product and control the demand. Thus the study of hydroelectricity requires a consideration of all the aspects which combine to constitute geography, and the three facets of the study, resources, development, and demand, make this study a geography in itself.

It is and has been essentially a dynamic geography; it is always changing with the new developments in production and markets. Therefore, there only rarely occurs a point at which a summary of the situation can be made. As a consequence, it is not so much situations as tendencies which must be dealt with. This survey of Norwegian hydroelectricity, as it was apparent during 1956, has emphasized certain tendencies which may be of paramount importance for the future of the Norwegian economy. There are three main ones.

1. Centralization of the production in a few stations with as large a size as the local natural conditions allow.

2. The closure of small stations as connection to a more widespread network provides a more reliable, steady current with greater quantities available.

3. The spread of co-operation in the working of stations so that the current will be as constant in quality as possible over a large area, and as much as is required will be available all through the year.

These three have been illustrated by the three examples chosen for detailed examination. Other examples probably exist and will in the future exist, but their full effect on a national scale cannot be measured until the publication of more complete statistical information—and this obviously is not practicable until the present intensity of constructional work begins to decline. The only opportunity apparent will be after the 1960–1965 period.

Having regard to these tendencies, then, the situation which can be forecast for this future census year is probably the following. There will be a larger proportion of the total capacity concentrated in the stations over 50,000 kw. [in capacity]. There will be a much larger number of the medium-sized stations and their average size will be much nearer to 50,000 kw. than to 1000 kw. The number of small stations will then have declined greatly, though because of the isolated nature of so many of the communities and habitations in Norway it is probable that there will still be many operating. Thus production will be concentrated into relatively fewer and perhaps actually fewer stations, of a much greater average capacity.

Served by these larger stations will be a network of transmission lines, con-

necting all the important producing areas and markets with a coverage over regions differing in their water supplies and relief characteristics. Thus a constant electricity supply should be available all over Norway to a distribution network which already covers almost all the possible domestic market. In addition to this may come an export of current during the summer to Sweden and Denmark, though this will depend on whether or not Norway's own requirements exceed the resources.

If they should exceed what can be produced from all the available sites, then even Norway must consider turning to nuclear power-stations. It then becomes a matter of economics alone. The cost of developing hydroelectric sites in Norway is very rapidly becoming greater; that of building nuclear power stations is and will be declining. There will come a point at which the cost of building and operating the nuclear station will be less than the costs of construction at water-power sites increasingly more difficult to develop. So to keep in the forefront of power production—and Norway must, for it is that on which the electro-chemical and electro-metallurgical industries, and therefore the export trade, are based—Norway has begun the construction of its first experimental atomic-powered station.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to the Norwegian State for the scholarship which made possible the research work in Norway, and to Norges Vassdrags- og Elektrisitetsvesen, especially their librarian, for assistance in collecting statistics.

THE FUNCTIONAL BASES OF THE CENTRAL PLACE HIERARCHY

Brian J. L. Berry and William L. Garrison

Mr. Berry is a Teaching Associate and Dr. Garrison is an Associate Professor in the Department of Geography, University of Washington. The present paper is one of several related to patterns of routes, urban sizes, and land uses stemming from recent research at that university.

IT is obvious that urban centers differ, each from others. On the intuitive level one notion of difference is that of classes of urban centers. The wealth of descriptive terms available illustrates this notion: hamlet, village, town, city, metropolis, and the like. The present study is concerned with this problem of the differentiation of centers into broad classes. In particular it provides original and urgent evidence that a system of urban center classes exists of the type identified on an intuitive level above.

There are several reasons for producing evidence of a system of classes (hereafter termed the hierarchical class-system) at this time. A considerable body of theory relating to city size, function, and arrangement has accumulated. One of the implications of this theory is that there exists a hierarchical class-system.[1] Ample evidence is available that other implications of this theory are valid, namely, that larger centers are functionally more complex than smaller centers, with this increasing functional complexity being accompanied by increasing size of the urban complementary region,[2] and that by virtue of the differential provision of central functions there is interdependence between urban centers in the provision of central goods and services.[3] On the other hand there has been no satisfactory evidence provided that would suggest that a hierarchical class-system of centers does indeed exist.

Despite many attempts at the assignment of towns to classes or grades[4]

[1] Walther Christaller: *Die zentralen Orte in Süddeutschland*, Jena, 1933, translated by C. Baskin at the Bureau of Population and Urban Research, University of Virginia, 1954; and August Lösch: *Die räumliche Ordnung der Wirtschaft*, Jena, 1944, translated by W. H. Woglom and W. F. Stolper as *The Economics of Location*, New Haven, 1954. The works of Christaller and Lösch are related in Brian J. L. Berry: *Geographic Aspects of the Size and Arrangement of Urban Centers*, unpublished M. A. thesis, Department of Geography, University of Washington, 1956. See also Walter Isard: *Location and Space Economy*, New York, 1956.

[2] W. J. Reilly: "Methods of the Study of Retail Relationships," University of Texas Bulletin 2944, 1929; idem: *The Law of Retail Gravitation*, New York, 1931.

[3] C. J. Galpin: *Social Anatomy of an Agricultural Community*, Research Bulletin 34, University of Wisconsin Agricultural Experiment Station, 1915; see also A. E. Smailes: "The Urban Hierarchy in England and Wales," *Geography*, Vols. 29 and 30, 1944, pp. 41–51; idem: "The Urban Mesh of England and Wales," Institute of British Geographers, *Transactions and Papers*, 1946, pp. 85–101.

[4] An extensive bibliography appears in Berry: *op. cit.* Some of the better known works are John E. Brush: "The Hierarchy of Central Places in Southwestern Wisconsin," *Geogr. Rev.*, Vol. 43, 1953, pp. 380–402; H. E. Bracey: "Towns as Rural Service Centres," Inst. of Brit. Geogrs., *Transactions and Papers*, Vol. 19, 1953, pp. 95–105; idem: "A Rural Component of Centrality Applied to Six Southern Counties of the United Kingdom," *Econ. Geogr.*, Vol. 32, 1956, pp. 38–50; Galpin: *op. cit.*; Sven Godlund: "Bus Services, Hinterlands and the Location of Urban Settlements in Scania," *Lund Studies in Geography*, Series B: Human Geography, Vol. 3, 1951; H. Carter: "Urban Grades and Spheres of Influence in South West Wales," *Scottish Geogr. Mag.*, Vol. 71, 1955, pp. 43–56; R. E. Dickinson: "The Distribution and Func-

(*Continued on next page*)

the converse has seemed to be more likely. The *a priori* methods used by most of the studies have led to serious doubts as to whether a class-system is present in other than arbitrary form, and to the alternate idea that perhaps instead of a class-system there only exists differentiation along a continuum.[5] Vining, for example, has written about the single best-known empirical study of the central place hierarchy, that of John E. Brush:[6]

> "There is no evidence . . . that exactly three natural partitions may be observed in this array of numbers of establishments . . . the terms hamlet, village, and town are convenient modes of expression; but they do not refer to structurally distinct natural entities. . . . Clearly, it is arbitrary to divide the array into three partitions rather than into a greater or lesser number; and similarly arbitrary is the determination of where to put the dividing points separating the different classes or types. Having drawn the lines, one may list certain kinds of activities which are typically found within each of the designated classes of center, . . . , not all members of a class will contain all the activities listed and most of the communities within a class will contain activities not listed. (This) . . . is not an independently derived basis for a classification of communities by type. Rather it is itself derived from a previous partitioning of an array which appears as something similar to an arrangement of observations that have been made upon a continuous variable."[7]

These criticisms of Brush's study may well be valid. That he used an arbitrary division and then proved what he had in fact assumed is without question (this criticism applies to more studies of central places than is generally realized).[8] The ensuing discussion serves to disprove the implication which Vining drew from this fact, that central places are differentiated along a continuum rather than in a class-system.

The finding of a hierarchical class-system verifies implications of theory and thus performs one classic function of empirical research in the accretion of knowledge. In the present case the need for the performance of this classic function is quite pressing because alternate theories are available to explain characteristics of systems of cities.[9] To the extent that verification is provided for previously unverified schemes, the present study increases the attractiveness of these schemes versus more recent schemes which do not include hierarchical concepts. It might be added that the present study provides examples of taxonomic methods for the empirical study of the hierarchical class-system and these methods may be found useful in ensuing studies; it was designed as a *critical study* which may be checked in the study area (Snohomish County, Washington) and which is capable of being reproduced by the methods provided in other areas and at levels of the central place hierarchy other than the universe of small centers considered in the present case.

THE HIERARCHICAL CONCEPT

The hierarchical class-system implication is an integral part of the spatial model of central places developed by Walther Christaller,[10] the generic base and single most important statement of central place theory. The model states that central places belong to one or another of class subsets. Each class

tions of the Smaller Urban Settlements of East Anglia," *Geography*, Vol. 17, 1932, pp. 19–31. Also see the very appropriate comments of H. C. Carter: "The Urban Hierarchy and Historical Geography: A Consideration with Reference to North-East Wales," *Geographic Studies*, Vol. 3, 1956, pp. 85–101.

[5] Rutledge Vining: "A Description of Certain Spatial Aspects of an Economic System," *Economic Development and Cultural Change*, Vol. 3, 1955, pp. 147–195.

[6] Brush, *op. cit.*

[7] Vining, *op. cit.*, pp. 167–169.

[8] See, for example, Carter, *op. cit.;* Smailes, *op. cit.*

[9] See W. L. Garrison and B. J. L. Berry: "The Distribution of City Sizes," unpublished manuscript, Dept. of Geography, Univ. of Washington, 1957; N. Rashevsky: *Mathematical Theory of Human Relations*, Bloomington, 1947; and H. A. Simon: "On a Class of Skew Distribution Functions," *Biometrika*, Vol. 42, 1955, pp. 425–440.

[10] Christaller, *op. cit.*

possesses specific groups of central functions and is characterized by a discrete population level of its centers. Note that (1) classes are arranged one to another in a hierarchy such that the central places of functionally more complex classes possess all the groups of functions of less complex classes plus a group of functions differentiating them from the central places of less complex classes, (2) discrete population levels of the central places of each class are thought to arise because the income which supports the population of a central place is brought into the center by the activities which provide goods and services for surrounding consumers. Since the central places of each class possess discrete groups of activities they also tend to have discrete population levels.

TABLE I

CLASSES OF CENTRAL PLACES AND ASSOCIATED GROUPINGS OF CENTRAL FUNCTIONS IN SNOHOMISH COUNTY, WASHINGTON

Central Functions	Classes of Central Places		
	A	B	C
Variates:			
Group 1_1	p	f	f
Group 2_1	-	p	f
Group 3_1	-	s	f
Attributes:			
General Store	p	-	-
Group 1_2	s	p	f
Group 2_2	-	p	f
Group 3_2	-	s	p

s-some; p-partial range; f-full range

*A Class A center, for example, provides a partial range of the functions of group 1_1, a few of the functions of group 1_2, and most, although not all, of the centers will have general stores.

AN OBSERVED HIERARCHY OF CENTRAL PLACES

Evidence is provided here that a hierarchy of central places does exist. In Snohomish County, Washington, the area in which the present study was undertaken, it was found that centers could be arranged into three types, called A, B, and C (Table I). These three types were defined on the basis of the presence of urban functions 1_1, 1_2, . . . , etc., in varying degrees. In other words, in Snohomish County it was found to be possible to treat central places taxonomically and derive center types A, B, and C (say, hamlets, villages and towns, respectively) on a functional basis. It was shown that these center types differ more one type from another than they differ within types.

The data utilized involved 33 of the smaller central places of the county (Fig. 1). Since the present study was in the interest of expediency limited to small central places, excluded from the field survey was the largest center in the county, Everett. Several of the smaller communities on the northern and southern margins of the county were also excluded. Reasons for the exclusion of these centers, an elaboration of the data used in the study, and relevant maps of the travel patterns of the rural residents to the central places are available elsewhere.[11]

Of the 33 centers studied, 20 were of class A, which contains the lowest complex of central functions; nine were of class B; and four were of class C, which contains the most complex grouping of functions. In these centers considered in toto it was possible to recognize 63 kinds of central functions (in addition four non-central functions and

[11] William L. Garrison: *The Benefits of Rural Roads to Rural Property*, Seattle, 1956, pp. 35–36; and R. G. Hennes, B. O. Wheeler, and W. L. Garrison: "Washington State Highway Impact Studies," *Proceedings*, Highway Research Board, 1957, forthcoming.

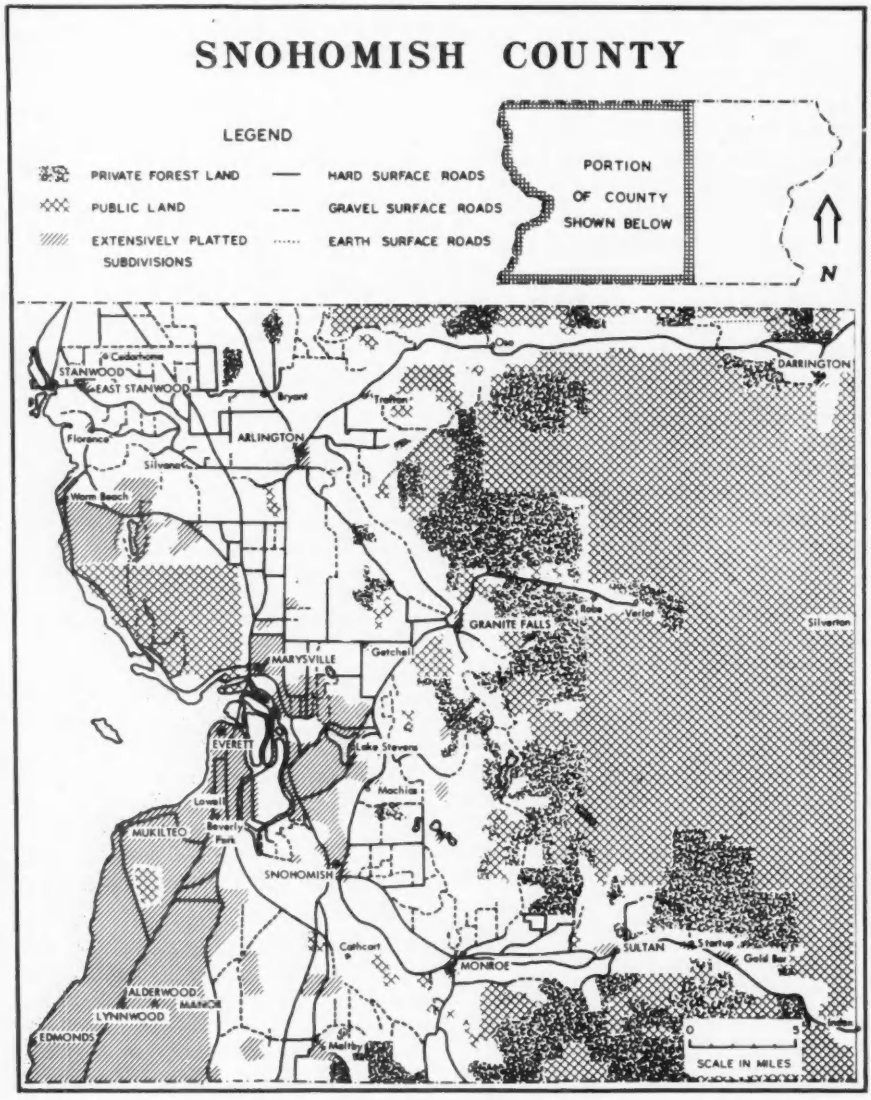


FIG. 1. Locational features of the study area.

other characteristics of the centers were included within the study).[12] These could be differentiated into seven classes of functions (three and four classes in each of the broad groups respectively), distinguished in terms of the hierarchical concept.

This preliminary summary of the

[12] These four non-central functions or other characteristics of the centers are: whether the settlement is an incorporated city and whether it possesses a water supply system, a sewage disposal system, or an office of the electricity distribution system.

data is at best quite gross. Any discussion of the exact nature of the hierarchy requires an elaboration of the functional classes and the classes of centers, and a clarification of what is meant by "some," a "partial range," and a "full range" of central functions. Too, it is necessary to detail the evidence on which the study is based, both to verify the viability of the classes and, because the classes evolve directly from the evidence, to establish the characteristics of the classification. The ensuing discussion provides this elaboration.

It will be noted that in the above paragraphs the hierarchical class-system of centers was assumed to follow from the class-system of functions. The assumption is derived from the implications of theory. A further note on this notion is included in the ensuing parts of the study.

THE ANALYSIS

The problem before us was to determine whether central functions fall into groups of classes, and, if so, whether these classes were associated with classes of central places, as theory suggests they ought to be. Therefore, the initial step in the research was to rank both central functions and central places. The second step was to apply tests to determine whether groupings occurred, and, if so, to discover whether there were significant differences between the groupings isolated.

RANKING THE CENTRAL FUNCTIONS

Fifty-two of the central functions were variates, i.e., numbers of stores performing these functions varied from place to place. The remaining functions and other characteristics considered in the study were attributes, i.e., central places either possessed a unit performing this function or did not possess such a unit. The method of ranking varied between these two sets.

Variates

Previous empirical studies indicated that relationships exist between the population of a central place and the number of units of any function which that place possesses and this is, of course, clear from common knowledge.[13] Christaller suggested that through the working of the income mechanism the population of a center was a function of the number of types of central goods and services the central place provided.[14] Hence it was specified that the population of a center is a function of the number of stores of each type. Fifty-two scatter diagrams were prepared with population, P, and number of stores, N, as parameters to determine the relationships between P and N for each function. Each of the diagrams had 33 points, one for each of the 33 central places. Best fitting curves of the exponential growth series $P = A(B^N)$ where A and B are the parameters to be estimated were fitted to each of the scatters using standard least squares techniques, after logarithmic conversion.

Given these 52 best relationships it was then possible to rank the central functions on the basis of the threshold population of the center which was necessary for the first complete store to appear, that is, by the value of P where $N = 1$ (Table II).

Attributes

Relationships between the 15 attributes and the populations of the centers in which they appear were determined by calculating the point biserial coefficient of correlation between each of the activities and the

[13] Reilly: *op. cit.*: C. R. Hoffer: *The Study of Town-Country Relations*, Bulletin 181, Michigan Agricultural Experiment Station, 1928.

[14] Christaller: *op. cit.*

TABLE II

THE FUNCTIONAL BASES OF CLASSES OF CENTRAL PLACES IN SNOHOMISH COUNTY: VARIATES

| | | | | CENTRAL PLACES | | | |

TABLE III

THE FUNCTIONAL BASES OF CLASSES OF CENTRAL PLACES IN SNOHOMISH COUNTY: ATTRIBUTES

			CENTRAL FUNCTIONS																
				1_2			2_2									3_2			
			General Store	Feed Mill	Post Office	Weekly Newspaper	Telephone Exchange	Incorporated City	Movie Theater	Bakery	Electricity Distribution	Water Supply System	Sewage System	State Liquor Store	Public Library	Printing Press	Used Furniture Dealer
		r_{pb}	.347	.265	.29	.458	.584	.615	.616	.619	.646	.646	.691	.691	.758	.759	----
CENTRAL PLACES	C	Marysville		1	1	1	1	1	1	1	1	1	1	1	1	1	
		Snohomish		1	1	1	1	1	1	1	1	1	1	1	1	1	
		Arlington		1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Monroe		1	1	1	1	1	1	1	1	1	1	1			
	B	Edmonds				1	1			1	1	1	1	1	1	1	
		Stanwood						1			1	1	1	1			
		East Stanwood						1			1	1					
		Lynnwood						1			1	1					
		Sultan		1	1	1	1	1		1	1	1	1	1	1		
		Mukilteo	1		1	1		1		1	1	1					
		Darrington			1		1	1	1		1	1					
		Granite Falls			1	1		1			1	1					
		Alderwood Manor		1	1					1					1		
	A	Lake Stevens	1												1		
		Beverly Park									1	1	1				
		Lowell			1						1	1	1				
		Silvana	1	1	1												
		Gold Bar			1												
		Startup			1												
		Warm Beach	1		1												
		Index			1												
		Machias	1														
		Cathcart	1														
		Maltby	1														
		Oso	1														
		Cedarhome	1														
		Bryant	1														
		Rabe	1														
		Getchell	1														
		Florence	1														
		Trafton	1														
		Silverton	1														
		Verlot	1														

population of the centers. Activities were then ranked in ascending order of these coefficients, r_{pb}, since it was observed that higher correlations were associated with occurrence in larger centers (Table III).[15]

THE MEASUREMENT OF GROUPINGS BETWEEN RANKED ACTIVITIES

Given the ranks of central functions it was then possible to employ tests to determine whether there were associated groups among them. The tests used again varied between the two sets of central functions.

[15] It is a characteristic of the point biserial coefficient of correlation, a statistic designed for the correlation of attributes and variates, that as fewer attributes occur, and as they occur in conjunction with the higher values of the variates, the correlation coefficient increases positively (compare Post Offices and State Liquor Stores); conversely, as fewer attributes occur, and in conjunction with the lower values of the variates, the correlation coefficient assures decreasing values (increasing negative values: compare Post Offices and General Stores).

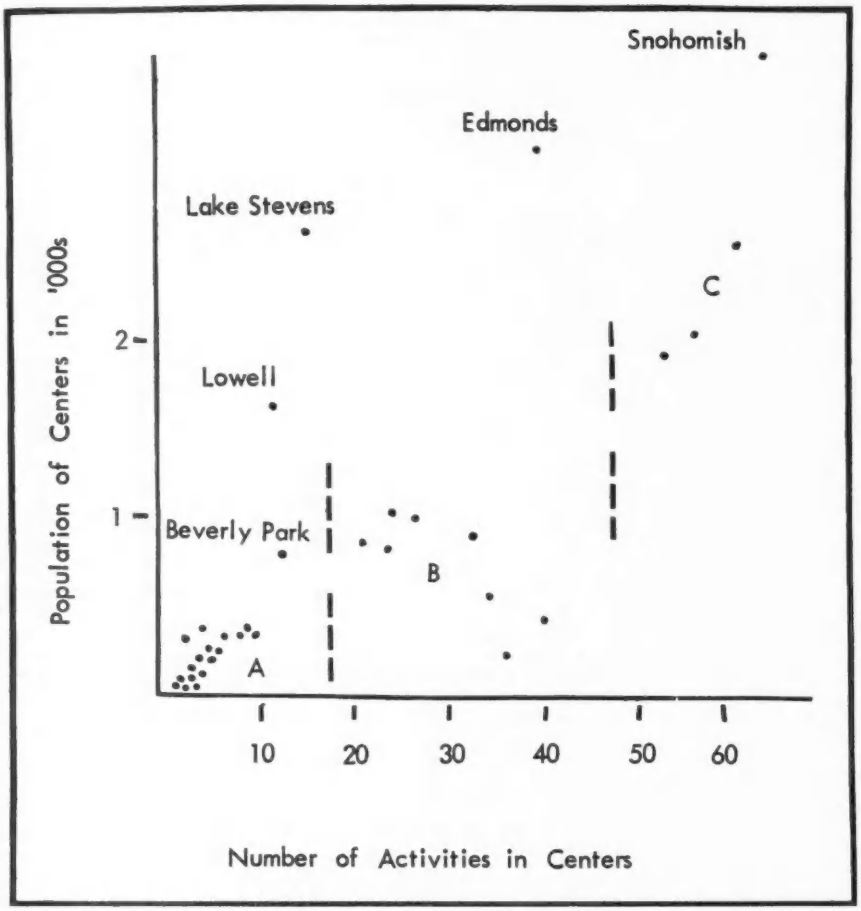


FIG. 2. Classes of central places in Snohomish County.

Variates

Threshold sizes were treated as points upon the population-size continuum. Using the techniques developed by P. J. Clark, this distribution of points was tested for randomness by using a χ^2 (chi-square) test for significant differences between expected and observed reflexive relationships.[16] The tests showed that the observed distribution of points was nonrandom at the 0.95 level of significance, and this observed distribution was nonrandom in a grouped rather than a "more even than random" manner.

Given this tendency for there to be grouping, and using Clark's criterion of a group—that every member of the group should be closer to some other member of the group than to any other

[16] These techniques consist of the examination of the reflexive relationships which exist between points on a line and the testing of these for significant differences with the expected random reflexive relationships calculated by Clark and Evans. See P. J. Clark and F. C. Evans: "Distance to Nearest Neighbor as a Measure of Spatial Relations," *Ecology*, Vol. 35, 1954, pp. 445–453.

point—three groups of central functions, 1_1, 2_1, and 3_1 were found to be present (Table II).

Attributes

Tests of significant differences between the r_{pb}'s were made at the 0.95 level of significance using standard techniques, and 12 of the attributes were found to fall into three groupings, 1_2, and 2_2 and 3_2 with general stores existing as a class apart (Table III).

RANKING AND GROUPING THE CENTERS

The central places were represented as points on the continuum of functional complexity by the number of functions each possessed. Clark's test of randomness was then applied to this distribution of points and the chi-square test showed that the distribution of points was nonrandom and grouped. Using Clark's concept of a group, three groups of central places, here termed A, B, and C, could be distinguished (Fig. 2 and Tables II and III).

THE CLASSES OF CENTRAL PLACES

Given groups of central places defined on the basis of numbers of functions performed, and groups of functions, it remained to be determined whether the latter could be said to be significantly associated with the former. Tables II and III were constructed and, utilizing the groupings, Table IV derived. This table records the number of stores per function per central place.

Analysis of variance between the cells in Table IV demonstrated significant differences to exist both between groups and between centers at the 0.95 level of confidence. Therefore, variations between groups are greater than variations within groups. This confirms the differential nature of the groupings derived utilizing the Clark techniques, and reveals the nature of the hierarchy of central places. As an extra step, it was found that general stores, the attribute existing as a group apart, were complementary with food stores (part of group 1_1), the coefficient of correlation being –0.634.

TABLE IV

NUMBER OF STORES PER FUNCTION PER CENTRAL PLACE IN THE CLASSES OF FUNCTIONS AND OF CENTRAL PLACES IN SNOHOMISH COUNTY, WASHINGTON

Central Functions	Classes of Central Places A	B	C
Variates:			
Group 1_1	0.65	2.91	6.29
Group 2_1	0.04	0.77	2.65
Group 3_1	0.01	0.21	1.00
Attributes:			
General Store	0.70	0.11	0.00
Group 1_2	0.20	0.45	1.00
Group 2_2	0.04	0.50	1.00
Group 3_2	0.03	0.28	0.88

*A value of 1.0 means that every center of the particular class in question will tend to have one store providing each function of the group of functions in question (for example, class C centers with functions of group 2_2).

FINDINGS

The data developed in constructing Tables II, III, and IV can be generalized into the gross findings which were presented earlier in Table I. It is apparent how the notion of classes of central places is defined with respect to the notion of functions. What is more, a technique has been provided whereby the hierarchical system may be isolated and identified, and the exact identification of an hierarchical system has been completed for Snohomish County. This is readily comprehended upon close examination of Tables II and III.

It may also be shown that the three classes of towns tend towards discrete

levels of population, as suggested by Christaller (Fig. 2). There are only four exceptions to the generalization of levels in terms of population—Beverly Park, Lowell, Lake Stevens, and Edmonds. It is significant that these are centers which have experienced very rapid increases in population in recent years, becoming dormitories for the Seattle area. Their functional paucity may be attributed (a) to the time-lag existing between population growth and the development of service industries, and (b) to the fact that, compared to other centers of their size, they serve relatively few people residing in immediately surrounding areas. As the time-lag diminishes the centers can be expected to experience increasing functional complexity and possibly a rise in class status. But the dominant dormitory function suggests that some differential will persist vis-a-vis centers of comparable size in the county.

THE SUEZ CANAL AT MID-CENTURY

Alan B. Mountjoy

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RECENT events have served to establish very clearly the significant influence of the Suez Canal on the economies of many nations, particularly those of Western Europe. Though the value and international character of the waterway have long been recognized, the notable changes in the volume, nature, and origin of flow of the Canal traffic since the war are not generally appreciated. It is the purpose of this paper, by an analysis of statistics, mainly supplied by the Suez Canal Company, to demonstrate these features, to assess the stature of the Canal as we enter the second half of the century, and to consider their significance on proposed Canal developments.

Traffic

Figure 1 reveals the remarkable increase in the flow of traffic through the Canal during the last decade. Both the rate and amount of increase are unprecedented in the Canal's history; by 1955 the net tonnage passing through the Canal was nearly four times the annual average for the thirties—an increase that it previously had taken nearly 40 years to accomplish. This graph (called by Siegfried "the temperature chart of international trade"[1]) truly shows the state of health of world trade, with its alternations between fever and depression. Much is reflected by its curves: the effects of two world wars, the 1926 General Strike in Britain (temporary cessation of exports, particularly coal), the Great Depression of 1929–32, Italy's ventures in East Africa 1935–39, and, more recently, the Abadan oil crisis of 1951. The graph gives a measure of the high place of the Canal in the pattern of international trade. It is here that the pulse of world trade can be felt.

This rapid growth of traffic is a result of both an increase in the number of vessels using the Canal and in their size. Whereas in any year during the prewar decade an average of about 5800 vessels passed through the Canal, the average number for the first half-decade of the fifties was 12,700. Had there been no disturbance to the Canal's operation it is likely that over 15,000 transits of the Canal would have been recorded in 1956. The average size of vessel using the Canal has also increased in a striking manner (Table II). From the eve of the First World War to that of the Second the majority of vessels in transit were of between 4000 and 8000 gross tons. In 1955 approximately 72 per cent of ships using the Canal were of over 8000 gross tons, while the number of those over 20,000 tons has been increasing steadily since the war. To a great extent this has been due to the increasing size of oil tankers, and their transits have been made possible by considerable dredging and improving of the navigable channel. The maximum draught authorized is 34½ feet, although in 1955 some experimental transits were made by oil

[1] A. Siegfried: *Suez and Panama*, London, 1940, p. 140.

TABLE I

SUEZ CANAL: FACTS AND FIGURES

Construction begun	1859
Canal opened	1869
Length of Canal	100 miles
Breadth (average at depth of 30 ft.)	200 ft.
Authorized draught	34 ft. 6 in.
Traffic—1870	
Number of ships	486
Net tonnage	436,609
Traffic—1955	
Number of ships	14,666
Net tonnage	115,756,398

PRINCIPAL DISTANCES

(In sea miles)

	Via Suez Canal	*Via Cape of Good Hope*	*Via Panama Canal*
London or Liverpool to:			
Bombay	6,250	10,700	.....
Kuwait	6,500	11,300	.....
Singapore	8,270	11,840	15,200
Hong Kong	9,690	13,160	14,100
Yokohama	11,250	14,570	12,520
Melbourne	11,000	11,900	12,950
Auckland	12,670	14,380	11,350
New York to:			
Bombay	8,200	11,450	.....
Ras Tanura	8,400	11,900	.....
Singapore	10,170	12,430	.....
Hong Kong	11,600	13,750	11,300

tankers with 35 feet draught. These tankers, of about 35,000 tons dead weight, are the largest that can pass through the Canal fully laden.

Statistics also show the steady decline in the British share of shipping passing through the Canal (Fig. 2). In the years 1869 to 1900 three out of every four vessels in transit were British. In the thirties this proportion had declined to one out of two. Even so, there was no near rival. Until the close of the last war it could be said, with Siegfried, that in terms of greatest use the Suez Canal was essentially British. Since 1945 the proportion of shipping using the Canal under the British flag has declined sharply although, in fact, the total British net tonnage passing through actually doubled during the period 1945–55. This changing share of the

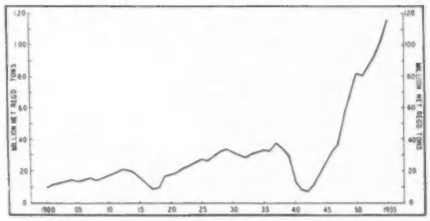


FIG. 1. Suez Canal traffic, 1900–1955.

traffic reflects the vigorous revival and expansion of the mercantile marine of such countries as Norway (which has built up a large tanker fleet), and the growing use of "flags of convenience" to avoid heavy taxation in a number of European states, including Great Britain. This explains the notable increase in Liberian and Panamanian shipping passing through the Canal since the war.

TRADE THROUGH THE CANAL

Figure 3 shows the notable changes in the volume and composition of the cargoes passing through the Canal. Northbound traffic from its very nature (heavy raw materials and bulk foodstuffs) has always been greater in weight than the southbound flow (consisting principally of manufactured articles, machinery, and fertilizers). This disparity has become greater in the last few years, the proportion of southbound cargo to total cargo falling from an average of 30 per cent in the thirties

TABLE II

SIZE OF VESSELS IN TRANSIT BY GROSS TONNAGE

(Proportion per hundred of all transits)

Year	*Under 4,000*	*4,001–8,000*	*8,001–12,000*	*12,001–16,000*	*16,001–20,000*	*Over 20,000*
	%	%	%	%	%	%
1890	85.0	15.0	....	....	...	...
1913	20.3	70.4	8.0	1.3	...	...
1938	8.7	56.1	27.7	3.3	2.4	1.8
1955	8.6	19.7	43.7	13.9	8.6	5.5

Source: "Le Canal de Suez (Documents Statistiques)," Suez Canal Co., Paris, 1950, pp. 18–19, and information supplied by the Suez Canal Co.

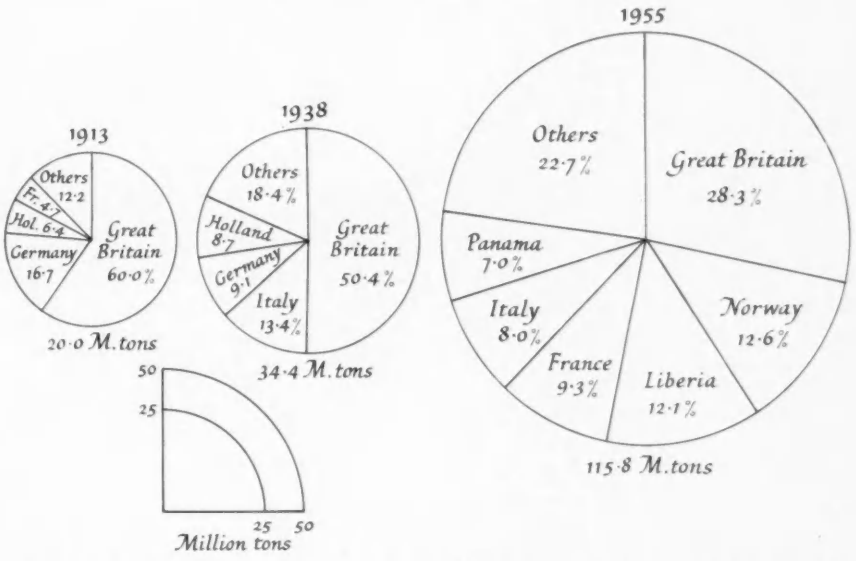


FIG. 2. Suez Canal: net tonnage by flag: 1913, 1938, 1955. (Figs. 2, 3, and 5 drawn at office of Royal Geographical Society.)

to 19 per cent in 1955, despite an increase in actual cargo tonnage from 8 million to 20 million tons. This trend is shown in Figure 4, although partly obscured in 1951–53 owing to the Abadan crisis which caused the virtual withdrawal of Persian oil from world markets and an increased flow of refined products *southwards* supplying local markets hit by the closing of the Abadan refinery.

The outstanding post-war increase in northbound oil cargoes is revealed as the principal cause of the great growth of traffic and trade through the Canal. Whereas an annual average of 4.5 million tons of oil and oil-products moved north during the thirties, by 1955 the amount had increased to 67 million tons. During the earlier period oil accounted for 24 per cent of northbound cargoes by weight; in 1955 oil provided 76.5 per cent of northbound cargoes. The fact that this is a one-way traffic (tankers returning in ballast) has accentuated the disparity between northbound and southbound trade. In 1955 approximately three vessels out of every five using the Canal were oil tankers. The changing emphasis as well as amount of trade is also shown in Figure 3. The southbound flow shows a steady demand for railway equipment after the boom years of railway building at the beginning of the century. Salt cargoes (much taken on at Port Said as ballast) have varied little in amount over the years. Metals and machinery, however, show an increase of 50 per cent over the thirties, cement cargoes have increased fivefold and fertilizers fourfold. The movement of these commodities mirrors the attempts now being made to speed the development of the lesser-developed areas south and east of the Canal.

One of the most noticeable changes during the last half century has been in the coal trade. In the early years of the century well over a million tons went south through the Canal each year.

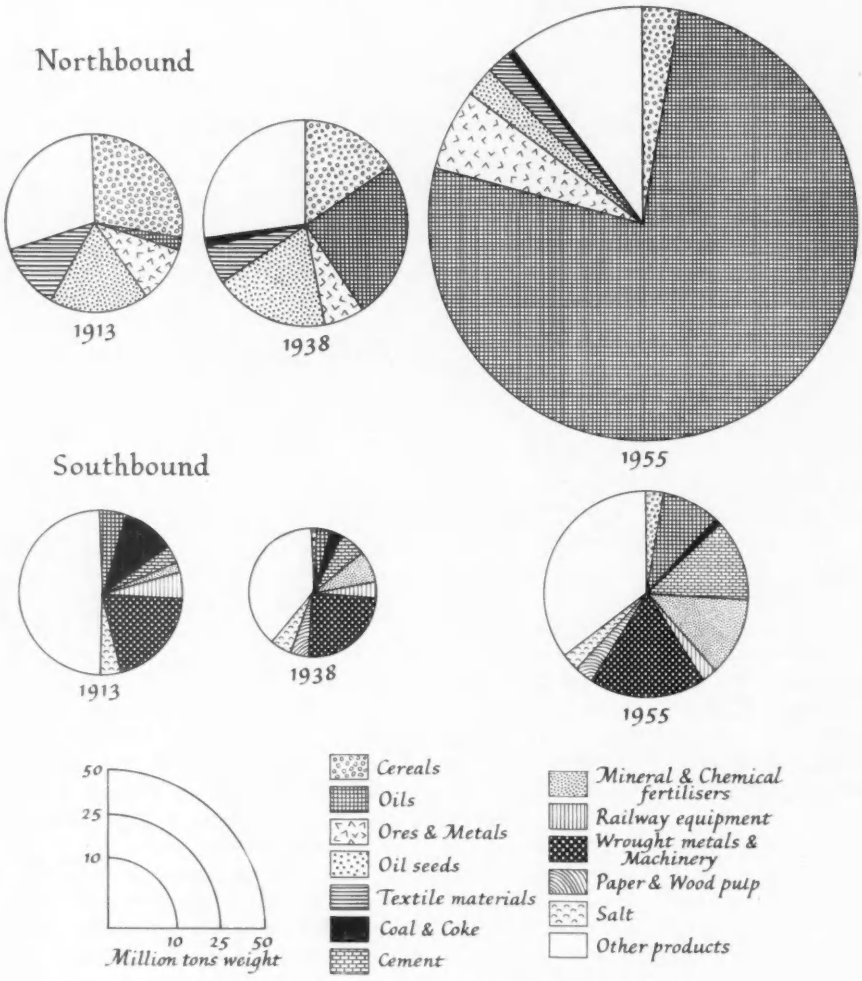


FIG. 3. Trade through the Suez Canal: 1913, 1938, 1955.

This trade showed a marked contraction after 1930, reflecting Britain's changing situation as the world's premier coal exporter, the growing competition from coal fields south of the Canal (India and South Africa), and the steady decline in demand for bunker coal as the numbers of coal-fired ships decreased. The virtual cessation of Britain's coal exports during the last decade has resulted in a reversal of flow of this commodity, and it is a measure of Britain's fuel problem that since 1946 coal cargoes passing through the Canal from the south have exceeded those from the north by one-and-a-half million tons. The decline in bunker trade may be deduced from an analysis of the motive power of the Canal shipping (Table III). Oil-burning vessels first passed through the Canal in 1908, and the first motor vessel in 1912. Their numbers have increased steadily

and since 1931 they have outnumbered coal burners which are fast becoming extinct. In 1913 the greatest number of coal-fired ships, 4984, used the Canal; in 1955 only 89 passed through. Whereas in 1929 Port Said had supplied 1,200,000 tons of coal and 385,000 tons of oil to ships' bunkers, in 1951 only 50,000 tons of coal were taken on, but oil bunkering reached 1 million tons.

TRADING AREAS

The Suez Canal offers the most direct route between Europe and the Indian Ocean, Australia, and the Far East. The relative and changing importance of these trading areas may be assessed from Figure 5 and Table IV. It should be noted that the available statistics are of net tonnage (i.e., shipping capacity) passing through the Canal both to and from these areas, and consequently the total is a combined figure and includes ships empty or in ballast. Without exception the volume of shipping from all areas south and east of the Canal has increased during the last 50 years, but the order of importance has changed considerably. The bulk of the early trade through the Canal came from the British Indian Empire and the Far East; indeed, it was mainly for the development of this trade that the Canal was excavated. Today, with its heavy oil shipments, the Persian Gulf area is the source of two-thirds of the traffic, whereas the former Indian Empire area with almost the same net tonnage as in 1913 accounts for a mere 8 per cent of the traffic. Europe was the destination of 85 per cent of the northbound traffic through the Canal in 1955. Passenger traffic has also been maintained at a much higher level than before the war. About a quarter of a million passengers were carried each year in the early thirties (before the considerable Italian troop transits). During the last five years the annual number has been just over half a million. A large part of the increase may be attributed to migration from Europe to the Antipodes[2] and in some measure to more frequent

TABLE III

MODE OF PROPULSION OF VESSELS IN TRANSIT

Year	*Number of vessels*			
	Coal-fired	*Oil-fired*	*Motor Vessels*	*Total*
1905	4,116	.....	.....	4,116
1913	4,984	83	18	5,085
1938	2,524	1,717	1,930	6,171
1955	89	6,971	7,602	14,662

Source: "Le Canal de Suez (Documents Statistiques)," Suez Canal Co., Paris, 1950, p. 22, and information supplied by the Suez Canal Co.

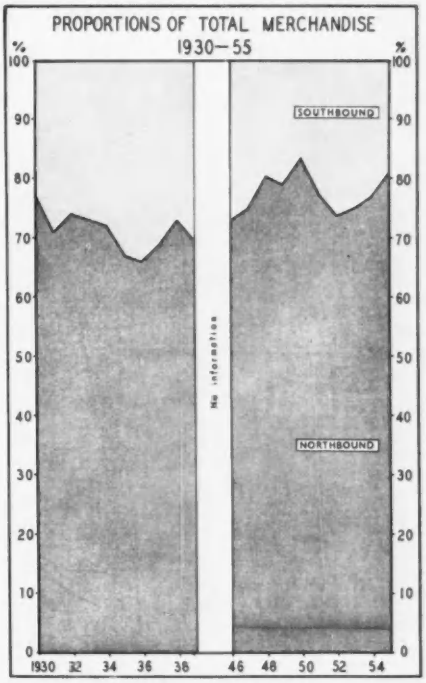


FIG. 4. Northbound and southbound trade through the Suez Canal, 1930–1955.

[2] The total number of permanent new arrivals in Australia 1946–54 was about 800,000. Most of these are likely to have travelled via the Suez Canal.

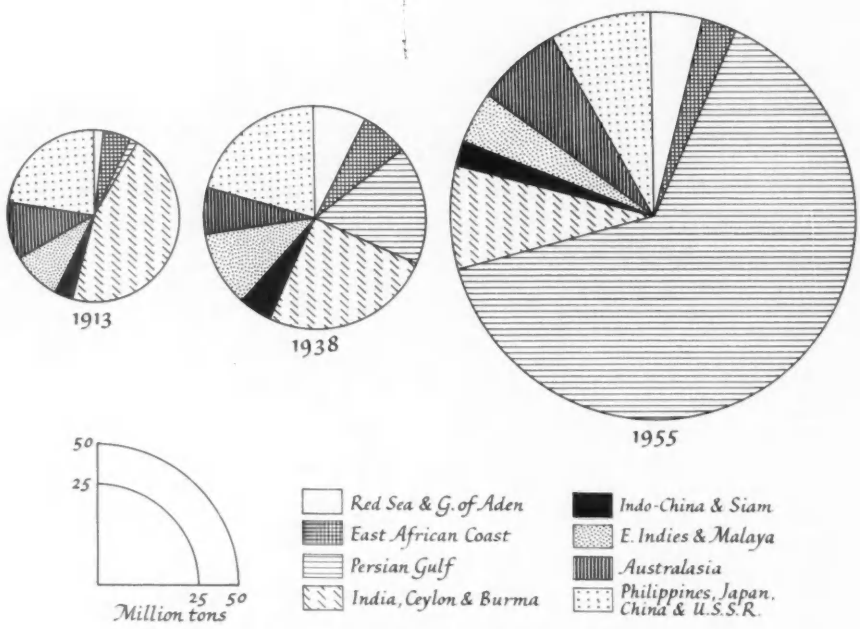


FIG. 5. Trading areas south and east of the Suez Canal: 1913, 1938, 1955.

British troop reliefs necessitated by the large short-service conscript element in the armed forces.

An unusual feature in an inflationary world is that the Canal dues in 1955 (7/– per net ton) were actually lower than the dues levied in 1935 (7/6). Even so, it will be seen that the larger cargo-liners and oil tankers must pay several thousand pounds each time they pass through the Canal. Shipping circles have feared that with nationalization the efficiency of the Canal service may be lowered, the period in transit may be lengthened and dues increased. If these fears become realized and are coupled with the danger of "political interference" with the operating of the Canal (liable to raise marine insurance rates), it is possible that a proportion of traffic may seek an alternative to the Canal route to Europe.

Of the dry-cargo trade that from Australasia, which receives least benefit from the Suez route, would be the first to favor the Cape route (threats of war in the past have brought such a response: in 1938, sixty-five per cent of the Australasian trade chose the Cape route, the normal proportion being about 40 per cent). However, there are many factors involved in such a decision and the recent blockage of the Canal with the diversion of traffic round the Cape served to underline the advantages of the Suez route, particularly for the regular cargo-liners between Europe and Australia. The distance between Britain and Australia is 1000 miles more via the Cape than via Suez, but a large cargo-liner (e.g., of 22,000 tons capacity) saves about £8000 ($24,000) Canal dues. However, such a liner would no longer bunker at Aden (one of the cheapest oil bunkering ports in the world owing to its proximity to the

TABLE IV

TRADING AREAS SOUTH AND EAST OF THE CANAL

(Net tonnage, northbound and southbound traffic combined)

(Thousands of tons)

Region	*1913*	*1938*	*1955*
Red Sea and Gulf of Aden littoral	273	2,632	3,355
East African Coast	1,038	2,359	4,411
Persian Gulf	296	5,733	74,195
India, Ceylon and Burma	9,099	8,734	9,363
Indo-China and Siam	639	1,571	2,356
Indonesia and Malaya	1,830	3,743	4,772
Australasia	1,988	2,268	7,542
Philippines, Japan, China, U.S.S.R.	4,442	7,033	9,526

Source: "Le Canal de Suez (Documents Statistiques)," Suez Canal Co., Paris, 1950, pp. 26–27, and information supplied by the Suez Canal Co.

Middle East oilfields), and must use more expensive bunkers which would put the oil bill for the round voyage up by about £28,000 ($84,000). Also, the Cape route involves long stretches with no ports of call; shipping using that route is deprived of trade and passengers from Colombo and the Mediterranean ports. On the whole for such a liner the loss per round voyage in choosing the Cape route between Britain and Australia has been estimated at £50,000 ($150,000).[3] A map will show that a diversion round the Cape would be far more serious to trade from the Indian sub-continent. Bombay is 4450 miles nearer Liverpool via Suez than via the Cape, and dues might rise to as much as £3 per net ton before the Cape route became preferable for Indian trade.

Table V demonstrates the degree of importance of the Canal to its major users, and gives a measure of assessment of the status of the Canal in relation to international trade. It will be observed that the countries whose trade relies on the Canal most are not those of Western Europe, as is commonly supposed, but India, Pakistan, Ceylon, and the states of Southeast Asia: Malaya, Thailand, and Viet Nam. Britain and France, with a quarter and a fifth of their trade travelling through the Canal, lead the European countries. In practically all cases in Western Europe the substantially higher proportion of imports than exports via the Canal is now a reflection of the great oil trade with the Middle East.

[3] *The Times*, 20 March '57, reporting the Chairman's address, Orient Steam Navigation Co.

THE OIL TRADE

Even before the "Egyptianization" of the Canal in July, 1956, it was becoming apparent that the rate of increase in the demand for oil by Western Europe was distinctly overtaking the rate of improvement and expansion of the navigable channel of the Canal. It is expected that European demand for oil will pass 240 million tons per annum by about 1965. The current Eighth Improvement Plan of the Canal Company envisages by the mid-sixties transit capacity for about 160 million tons of oil a year, and pipe lines operating to the Mediterranean (now with a through-put of 40 million tons a year)

TABLE V

THE SUEZ CANAL AND WORLD TRADE

(Proportions of countries' trade passing through the canal)

(1953–1954 average, calculated on basis of weight)

Country	*Per cent of exports*	*Per cent of imports*	*Per cent of total trade*
India and Pakistan	55.7	41.5	47.5
Ceylon	38.6	39.7	39.4
Burma	14.2	25.5	18.6
Malaya	30.8	20.2	24.1
Indonesia	15.1	20.7	16.4
Siam and Viet Nam	13.4	32.9	24.0
Australasia (inc. New Zealand and Pacific Is.)	22.4	19.2	22.5
U.S.A.	2.8	7.9	5.9
Italy	26.2	16.9	18.6
France	11.1	28.1	22.1
United Kingdom	15.9	27.9	24.3
Belgium	9.1	13.9	11.7
Netherlands	7.8	19.0	15.5
W. Germany	8.8	7.3	7.9

(By courtesy, Oxford University Press.)

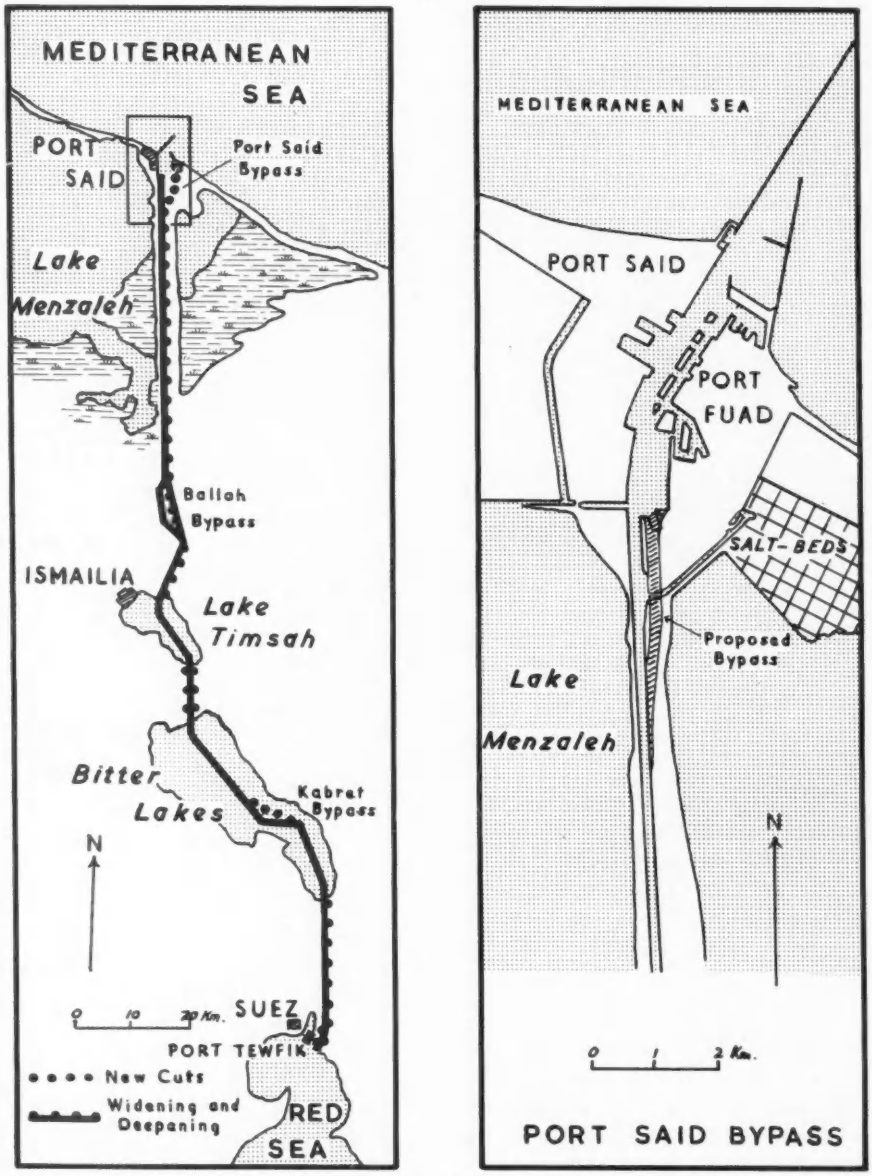


FIG. 6. The Eighth Suez Canal Improvement Programme. This was begun in 1955 with work on the Port Said by-pass, necessary for the future assembly of southbound convoys. The Egyptian Suez Canal Authority has stated that it will continue with the Improvement Programmes of the Suez Canal Company.

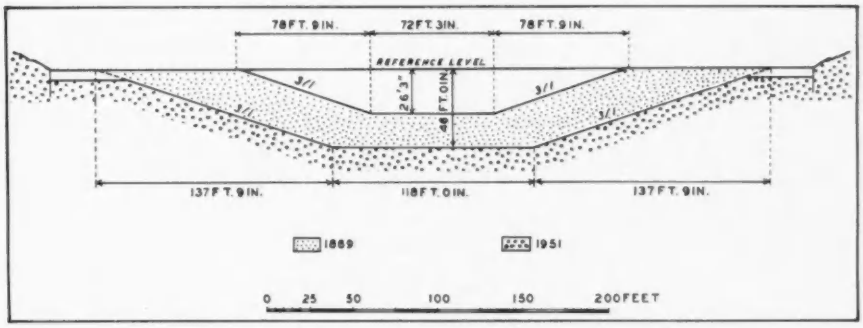


FIG. 7. Sections through the Suez Canal, 1869 and 1951.

might well be increased to take 60 million tons by that time. The problem of demand exceeding Canal and pipe line capacity may well arise in the mid-sixties, and by 1956 the oil industry and the Canal Company were examining the solutions available and formulating a Ninth Improvement Plan.

The stranglehold exhibited by the recent blocking of the Canal and cutting of pipe lines, allied to the general political situation in the Middle East, render less attractive entire reliance upon the expansion of existing oil-carrying routes to the Mediterranean, whether by further pipe lines or by the widening of the Canal. The oil industry has been hardening to the opinion that by the mid-sixties significant quantities of oil will travel to Europe via the Cape. This is a much longer voyage (71 as opposed to 45 days for the round voyage from the Persian Gulf) and, to help offset the heavier cost, very large tankers will be used. A tanker to carry 60,000 tons of crude oil requires less than twice as much labor, steel, and other materials to build as two tankers, each to carry 30,000 tons. It requires less fuel to drive than two 30,000 ton ships of the same speed, and its crew need be but little larger than that of one 30,000 tonner. Flexibility is lost, however, in that few ports can accommodate, service, and overhaul tankers of 50,000 tons and above, and such ships will be limited to the particular routes where these facilities can be provided.

The Eighth Improvement Plan (Fig. 6)—begun in 1955 and originally intended to be completed by 1960[4]—is intended to provide for the transit of 18,000 ships a year (14,666 in 1955) including tankers of 36 feet draught each carrying about 40,000 tons of oil, while 65,000 ton tankers could pass through partly loaded or in ballast. The tentative Ninth Improvement Plan, which looks ahead to beyond 1970, envisages a deepened and widened Canal able to take tankers of 60,000–65,000 tons. This suggests that tankers of 60,000–65,000 tons will be the compromise size for the next few years: able to stand better the extra 50 per cent mileage of the Cape route, or passing through the Canal partly loaded and being "topped up" at Mediterranean ports, ultimately being able to pass through the Canal itself. Return journeys could be through the Canal in ballast.[5]

[4] The Egyptian Suez Canal Authority has announced that it will continue with the development projects of the Suez Canal Company.

[5] The giant tankers of 80,000–100,000 tons dead weight, which are unlikely ever to be able to pass through the Canal and which can be handled by a very limited number of ports in

(*Continued on next page*)

FIG. 8. Port Said in 1947. Over 15,000 vessels use the port annually, ranking it among the world's most important ports. (By courtesy of the Suez Canal Company, London.)

CANAL IMPROVEMENTS

In 1869, when the Canal was first opened, at certain points the depth of channel was not more than 17–18 feet. The growing number of vessels using the Canal and the increasing size of vessel has necessitated a series of improvement works which have gone on almost continuously since that date. The magnitude of these works has not been generally appreciated. A great handicap to the Canal has been the relatively narrow channel, which does not permit two ships to pass one another without one stopping (Fig. 7). The original navigable channel was only 23 meters wide (72 ft. 2 in.) at the bottom, and it was planned that the passing of vessels should take place at sidings cut at 10 km. intervals. It was hoped to remove this handicap by the second program of improvements, begun in 1886, but by 1901 the tendency for the draught of ships to be increased decided the Canal Company to concentrate on the deepening rather than further widening of the Canal. Also, although by this time the navigable channel had been widened to 36 meters at the bottom, the increasing breadth of ships still precluded their passing one another in transit.

Thus, until 1939, the series of improvement plans was concerned more with increasing the depth of the Canal rather than widening it. Early transits of the Canal took an average of 40 hours. By 1939 this time had fallen to approximately 13 hours, but has been about 15 hours since 1950. From a daily passage of 2–3 vessels in the 1870's the average in the 1930's rose to 17 or 18. Since the war the daily number has increased to an average of 42, and this traffic has

the world, are most likely to be employed on the route from the Persian Gulf to the Eastern seaboard of the United States. In 1955 the United States imported from the Persian Gulf, via the Suez Canal, 8.6 million tons of crude oil.

FIG. 9 (left). The problem of vessels passing one another in the Canal became acute as they increased in size and numbers. The navigable channel is not wide enough to allow two vessels to pass without one making fast to the Canal bank. Since 1948 a convoy system has operated and the problem has been overcome by using specially prepared by-passes. (By courtesy of the Suez Canal Company, London.)

FIG. 10 (right). The maritime canal, the road, the fresh water canal, and the railway between Port Said and Ismailia, compressed between Lake Menzaleh and El Mallaha Lagoon. (By courtesy of the Suez Canal Company, London.)

had to be handled (since 1948) by means of a convoy system. Four convoys a day (two each way) leave Port Said and Port Tewfik. Two by-passes have had to be made to allow these convoys to pass one another (Fig. 6). One, at Kabret, about one-third of the distance along the Canal from Suez, makes use of the Great Bitter Lake. The other, approximately one-third of the distance from Port Said, is by means of a new channel 12 kms. long at Ballah, just south of El Qantara (completed 1951) (Fig. 10). With this system the present Canal has practically approached the limit of its traffic capacity. In order to increase the total traffic the regulation speed for ships was raised from 14 to 15 kms. an hour as from November, 1951. This proved harmful to the Canal banks, and it was difficult for the heavily laden northbound tankers to maintain such a speed, and from 1954 their convoy speed was reduced to 13 kms. an hour.

Basically the Canal is a ditch excavated in sandy soil, and unlike the Panama Canal the problem of big ships is not concerned with limitations due to size of locks (the Canal is at sea level and there are no locks), but of the breadth and depth of the navigable channel with special relation to the soft material of the Canal banks.[6] Continuous dredging has proved to be the only complete answer to the erosion of the banks by passing shipping, and normally it is carried on day and night. The speed of the bigger ships has to be carefully controlled to avoid landslides along the banks with corresponding silting up of the bottom. It is the need for this constant maintenance (never a strong point with the Egyptians) that makes some observers apprehensive for the future of the Canal.

[6] For most of its length the edges of the Canal are protected to a depth of about 2 meters. Several types of bank protection are used—asphalt, reinforced concrete, metal sheeting piles—but all deteriorate with time and suffer particularly from the eddies produced by passing convoys.

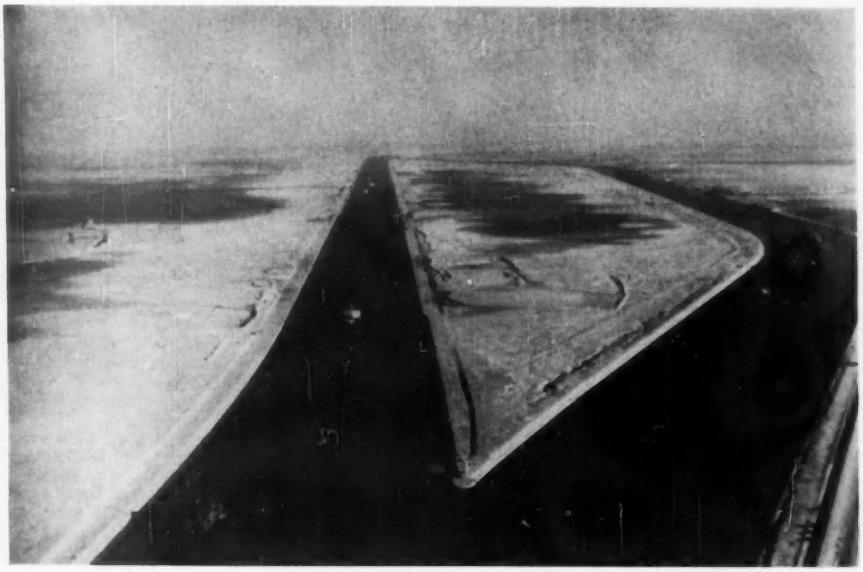


FIG. 11. The by-pass at El Ballah, completed 1951, looking south. This by-pass and that in the Great Bitter Lake have permitted the passing of convoys and obviated the need for the passing of vessels in the Canal proper. (By courtesy of the Suez Canal Company, London.)

It is clear that the remarkable increase in numbers and size of vessels using the Canal during the last decade has caught up with the Canal improvement projects; so much so that, although the Eighth Plan was only commenced in 1955, as we have seen the Company in 1956 began investigations and planning for a Ninth Improvement Plan. The growing pressure of traffic demands a considerable extension of the two-way traffic sections, and tentative proposals are that nearly two-thirds of the total length of the Canal (101 kms. out of 162 kms.) should be so enlarged, leaving only two short, single-way sections of 30 kms. each. The increasing size of tankers presses for a wider channel: to accommodate 60,000 ton vessels the single channel would have to be 330 feet wide, and provide a minimum depth of 49 feet of water. No decision was made as to whether the new two-way sections are to consist of two separate single-way canals, or one large canal in which convoys could pass, which would need a new channel of 820 feet width. These projects, with additional ancillary works at both Port Said and Suez, will involve the excavation of 500 million cu. yds. of material (five times the amount dug in the original cutting of the Canal), will take 12 years to accomplish (i.e., to 1972), and will cost about £100 million ($300 million).

CONCLUSIONS

The recent closure of the Canal brought no sudden catastrophe to Europe's economy, but its effects have been felt in practically every country, and particularly in France and Britain. The increased demand on shipping because of the longer voyages (see Table I) forced up freight rates by as much as 100 per cent, inevitably having repercussions upon the whole economy. The direct effects of the closure included the slow-

ing down of industrial expansion, an increase in industrial and food costs, restriction on the use of oil fuels, and a lowering of dollar reserves. Exports to Eastern markets were seriously delayed, inevitably encouraging the countries concerned to develop their own manufacturing facilities or turn to non-European supplies. The closure was regarded as temporary; emergency measures and co-operation, and the running down of stocks all helped to cushion its effects. The long-term effects may be more important. Attention has been focussed upon Western Europe's chronic and growing dependence on oil imports, particularly from one geographical region, and, consequently, upon the vulnerability of Western Europe's economy by interference with those supplies. It is to be expected that increased investment will be encouraged in the search for other oil sources in Europe and dependent territories, on the expansion of nuclear energy production, on the increase in oil storage capacity, and on increased tanker tonnage.[7] Nevertheless, it is a geographical fact that the cut through the Isthmus of Suez offers the most direct and economic route between the complementary areas of oil production and consumption of the Middle East and Europe and it may be expected, despite the development of other resources, that this trade must remain substantial and will continue to expand.

Thus, assuming political differences settled, if the sharp upward movement of Canal traffic of the last decade continues, it will necessitate the most far-reaching improvement schemes in the Canal's history. It will mean that at its centenary the water route will be markedly different from what it has been for nine-tenths of its life. All these great projects, which the Canal Company estimated could be paid for out of rising revenues, are essential if the Canal is to meet the steadily expanding one-way traffic of oil from the Middle East to Europe. It is the growing volume of oil traffic and the growing size of oil tankers that provide the spur to development. It is unlikely that any of the largest ocean liners would find adequate remuneration on any routes passing through the Canal, while the moderate increases in dry cargo trade have been well within the capacity of the present canal. Recent events have amply demonstrated the stature of the Canal in world affairs, and the changing pattern of "tonnage by flag" reveals that in another sense the Canal is becoming even more an international waterway. It is still possible that within two decades up to eight times the present quantity of oil might pass each year through the Canal, and Europe's dependence upon this route could well be even more complete than it is today.

[7] Britain's Minister of Transport has declared, "Every effort will be made to build bigger tankers, to deepen ports and harbours, to build new pipe lines and thus to reduce the dependence of the world on the Suez Canal. The Government are determined to play their full part in this task and thus make our economy steadily more independent of the Canal." *The Times*, May 7, 1957.

RAILWAY TRAFFIC AND AGRICULTURE IN NEW ZEALAND

William H. Wallace

Dr. Wallace, Assistant Professor of Geography at the University of New Hampshire, spent three years as Lecturer in Geography at Auckland University College. The present paper is based on material from his University of Wisconsin dissertation.

THAT the New Zealand economy is based upon agriculture[1] is evidenced by the fact that agricultural products normally contribute between 60 and 70 per cent of the total value of national production, and also by the fact that products of pastoral farming alone usually constitute more than nine-tenths of the value of the dominion's exports. It is, therefore, only natural that the New Zealand railway system[2] should be intimately related to the country's agricultural activity. Indeed, a large part of the railnet was built, either in response to the needs of farming, or in order to encourage agricultural development. Today, rail traffic provides a useful means of assessing the flows of farm products and farm supplies in New Zealand, and the nature of this traffic is a reflection of the character of agriculture in various parts of the dominion.

The interrelationship between the railways and agriculture is made closer by the dominance of railways in New Zealand's internal freight transportation. In the years since the end of the Second World War, New Zealand's railways have carried approximately five times the tonnage handled by coastal shipping. Highway competition is severely restricted by law. In areas where rail service is available, trucks are generally limited to hauls of 30 miles or less. Exception is made in the case of fat lambs, which are permitted truck journeys of as much as 50 miles in competition with train service. As a result of these statutory provisions, trucks rarely haul goods for distances of more than 30 miles, and railways seldom carry freight over shorter distances.

Considering the importance of agriculture in New Zealand, and the close relationships between farming and the New Zealand Railways, it is not surprising that haulage of agricultural products and supplies amounted to more than a third of all net ton-miles of freight transportation service rendered by the railways during the period covered by this study. Detailed traffic data are not available for all agricultural commodities and supplies, and this analysis is necessarily limited to traffic in the most important types of agricultural products and supplies hauled by the railways: livestock, dairy products, wool, frozen meat, wheat, agricultural lime, timber, fuels, fertilizer, and miscellaneous manufactured goods. This study is based largely on traffic data compiled by the railways for

[1] In New Zealand, a distinction is made between agricultural and pastoral activity. The term agriculture is used in this paper in its broad and generally accepted sense.

[2] The railway system here considered is the New Zealand Government Railways, which make up practically the entire railnet of New Zealand. In addition, there are a few short, private lines which feed timber, coal, and other bulky goods into the government system.

the fiscal year ended March 31, 1953, and the conditions analyzed are those that prevailed during this year. However, this paper is written in the present tense to facilitate fluency of expression, and important changes that have occurred since 1953 are described in appropriate footnotes. The period April 1, 1952, to March 31, 1953, is considered a satisfactory example of "contemporary" conditions because it was lacking in major economic, political, and social upheavals. Rail traffic during this year was similar to that in earlier and later years, and was in keeping with the general increase in traffic which began after the depression of the 1930's and has continued through the Second World War and the post-war period.

On the New Zealand Railways, traffic related to agricultural activity is composed of three basic types of movements: (1) movements of finished agricultural products from producing areas toward markets; (2) movements of agricultural commodities from one farming area to another; (3) movements of supplies from manufacturing and extractive industries into agricultural areas (to some extent, this traffic is reciprocal to the farm-to-market movement described as the first type above).

GENERAL CHARACTER OF AGRICULTURE IN NEW ZEALAND

In New Zealand, agriculture is based primarily upon cattle and sheep and their products. Cattle and sheep each make up nearly half of New Zealand's livestock units[3] and also contribute approximately equal shares to the value of the dominion's agricultural production.[4] In addition, the South Island's farms produce a quantity of wheat that supplies somewhat less than half of domestic needs; and various types of fruit and vegetable crops, mainly for the New Zealand market, are of local importance in districts scattered over the dominion. New Zealand agriculture is dominated by four major types of farm units.

On the very extensive stations[5] of the South Island High Country (see Fig. 1), hardy fine-wool sheep (merino and half-bred[6]) graze on the natural pastures that are found in the hills and mountains of this region. Because of the severe climatic conditions and the poor quality of grazing in the High Country, it is difficult to maintain flock numbers and impractical to fatten sheep. Thus, there are few surplus animals, and the only important product of High Country sheep stations is wool.

A much more important part of New Zealand's livestock rearing activity takes place on surface-sown pastures[7] of medium to low quality. Holdings based on pastures of this type are called extensive pastoral farms; they occupy the hill-country areas that are peripheral to most parts of the North Island railnet, and are also found in the hills that are marginal to the railnet of the eastern parts of the South Island (Figs. 1 and 2). The primary products of stations of this type are stock for fattening elsewhere, breeding ewes for sheep flock replacement, and wool. Particularly on the North Island, and to a lesser extent on the South Island, beef cattle (mostly Angus and Herefords) are kept to crush weeds and scrub growth in rough, sur-

[3] A livestock unit is equal to one horse, or one cow, or seven sheep, or seven swine. In 1952, there were in New Zealand 173,922 horses, 5,164,689 cattle, 35,296,911 sheep, and 565,723 swine.

[4] Except during times of strongly inflated or deflated wool prices.

[5] In New Zealand, the term "station" is applied to extensive holdings of pastoral land in much the same sense that the term "ranch" is used in the United States.

[6] Half-bred sheep are sheep that have been developed by crossing merinos with long-wool sheep.

[7] Surface-sown pastures are established by sowing seed on unplowed land that has been cleared of forest and burned over.

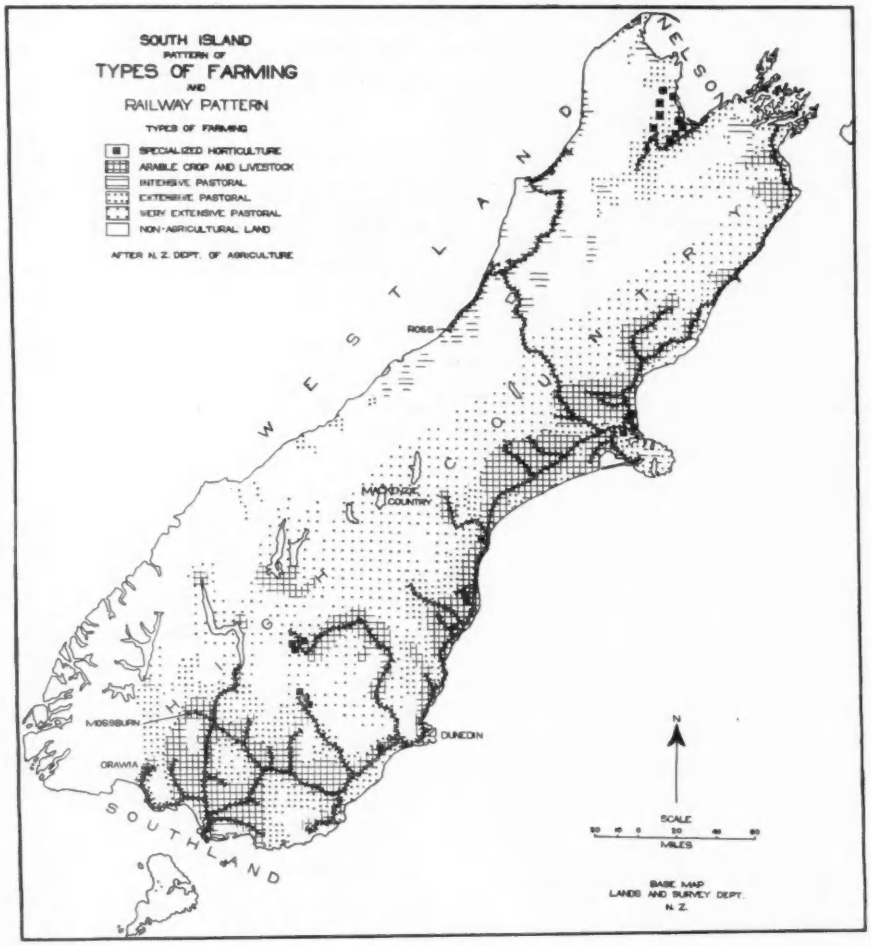
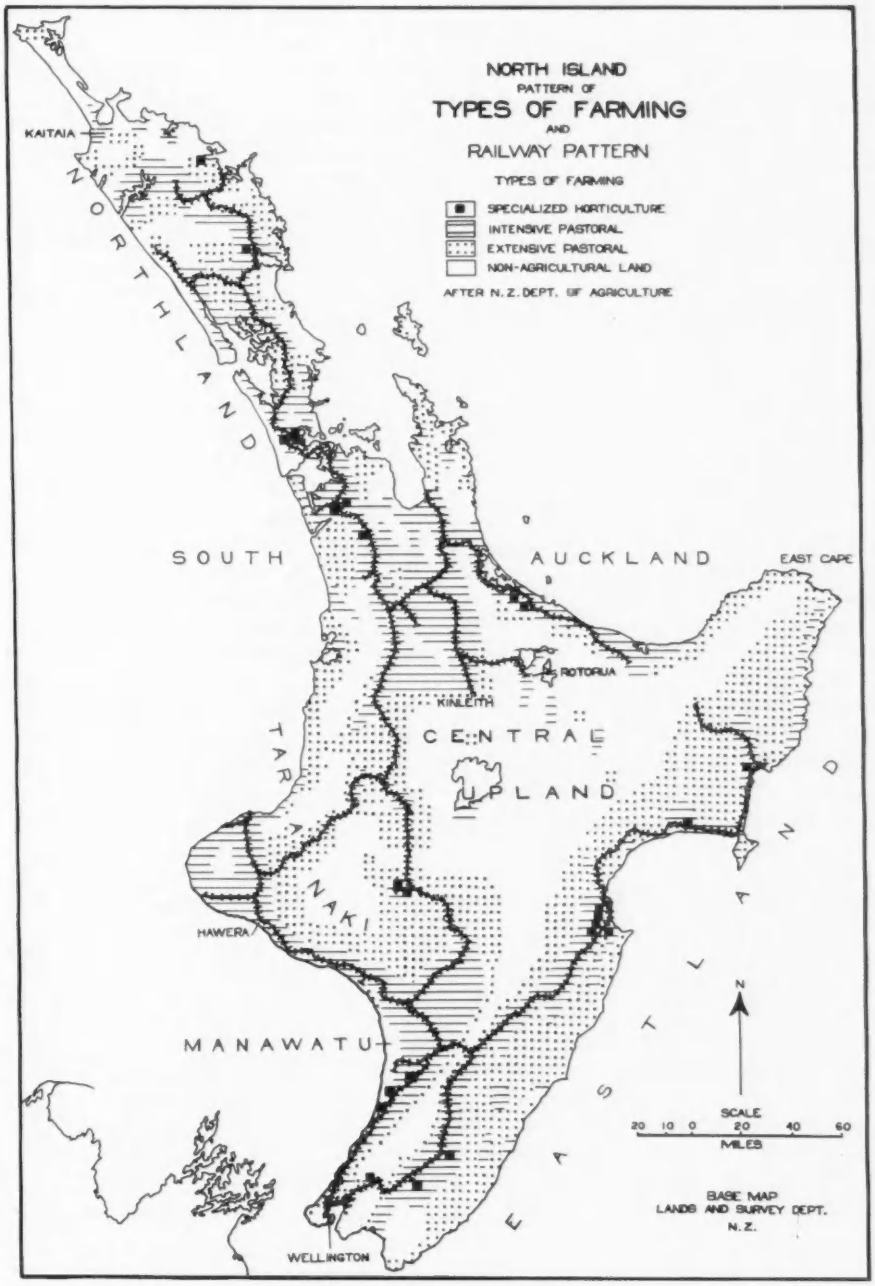


FIG. 1.

face-sown pastures which are used primarily for sheep grazing. These beef cattle are shipped from sheep stations in large numbers; most are to be fattened in more intensive farming areas, but some are fattened stock traveling directly to abattoirs or freezing works.

The intensive pastoral farms on the plains of the North Island are the most productive of New Zealand's agricultural units (Fig. 2). In these areas, the agricultural system is based primarily upon the grazing of high-grade permanent pastures which have been established by plowing and planting grasses. Operations on these intensive pastoral farms may center around sheep production, or concentrate on cattle rearing, or be a combination of both activities. Cattle husbandry on this type of holding is almost invariably dairy farming. Except within the "milksheds" of the larger towns, New Zealand's milk and cream are processed into butter, cheese,


NORTH ISLAND
PATTERN OF
TYPES OF FARMING
AND
RAILWAY PATTERN
TYPES OF FARMING
SPECIALIZED HORTICULTURE
INTENSIVE PASTORAL
EXTENSIVE PASTORAL
NON-AGRICULTURAL LAND
AFTER N.Z. DEPT. OF AGRICULTURE
KAITAIA
NORTHLAND
SOUTH AUCKLAND
EAST CAPE
ROTORUA
KINLEITH
CENTRAL PLATEAU
TARANAKI
HAWERA
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LANDS AND SURVEY DEPT.
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FIG. 2.

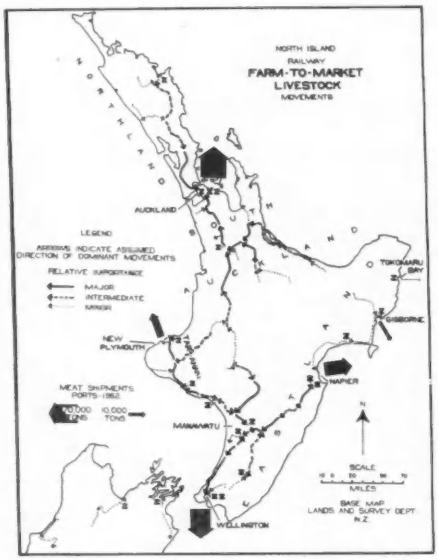

FIG. 3

and other dairy products at factories which dot the dairy farming districts. Large numbers of cattle, including calves, surplus and over-age dairy stock, and some fattened beef animals, are also shipped from New Zealand's dairy farms. Although intensive pastoral sheep farms derive considerable income from the sale of wool, their operations are focused upon the production of fat lambs and mutton sheep which are sold to freezing works and abattoirs.

On the plains of the eastern coast of the South Island, the dominant types of agricultural holdings are arable crop and livestock farms. (See Fig. 1.) These farms usually have land in semi-permanent pastures, fodder crops, and cash crops. Operations may center on dairy production, the production of fat lambs and sheep, or more rarely cash grain crops. Commonly, the output of a farm is a combination of these products.

FARM-TO-MARKET MOVEMENTS

The most important farm-to-market traffic flows on the New Zealand Railways are made up of livestock traveling from producing areas to freezing works, and thence to exporting harbors. Also significant are the considerable tonnages of dairy products that originate at rural factories and are shipped by rail to export wharves, and the flow of grain from South Island arable crop and livestock farms to urban consumption centers on that island and to ports for shipment to the North Island. Wool shipped from farms to harbors with overseas connections is another important part of farm-to-market agricultural traffic on the New Zealand Railways.

Livestock Moving from Farm to Market

The outstanding livestock traffic movement on the New Zealand Railways carries cattle and sheep from North Island intensive pastoral farms to freezing works that are located at or near focal points in the railnet[8] (Fig. 3). Fat lambs and mutton sheep, and calves and surplus and fattened cows are loaded in large numbers at depots serving the intensive pastoral farms on the plains to the north and south of Auckland. This stock moves to the three large freezing works adja-

[8] The analysis of livestock traffic in this paper is based upon statistics for inward and outward traffic at each officered railway station. These data were supplemented by field observation, and correspondence and conversation with railway traffic officials.

New Zealand Railways statistics group horses and cattle together. However, because there were 5,164,689 cattle and only 173,922 horses in New Zealand in 1952, and since cattle are much more likely to be shipped about the country, no great error results from considering this traffic as composed entirely of cattle. Railway statistics do not differentiate between cattle and calves; calves usually constitute about half of the total number of animals handled.

New Zealand Railways statistics also group sheep and pigs together. However, because there were 35,296,911 sheep and only 565,723 swine in New Zealand in 1952, no great error results from considering this traffic as composed entirely of sheep. Sheep usually constitute around 95 per cent of the total number of sheep and pigs hauled.

cent to this city, and to the two smaller works situated in Northland and South Auckland. Additional, though smaller, numbers of sheep and cattle travel to these meat-processing plants from extensive sheep stations which surround the intensively farmed plains. Processed meat from all five works is railed to Auckland wharves, making this port New Zealand's premier meat exporter.[9]

In a similar manner, the intensive pastoral farming districts along the coast between Taranaki and Wellington ship large numbers of animals to the seven freezing works which are situated near the ports and rail centers of this region. Farms in near-by parts of Eastland and extensive sheep stations on the rougher lands in the interior of the island also make considerable contributions to livestock traffic focusing upon these coastal meat processing plants. Meat from the more westerly of these seven freezing works moves by rail to New Plymouth for export, but the bulk of the output travels to Wellington's wharves for shipment, enabling this port to rank second only to Auckland among the dominion's meat shipping harbors.

Eastland's meat animals come in part from intensive grassland farms on its scattered plains, but the vast area devoted to extensive sheep stations also makes a heavy contribution to the livestock traffic that converges upon the region's six freezing works.[10] As we have already seen, the farms of East-

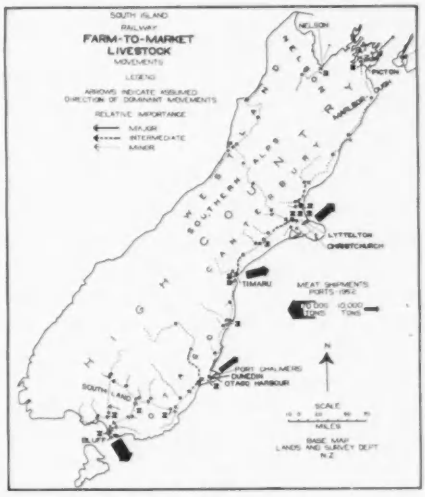

FIG. 4.

land also ship some stock to freezing plants in the Wellington and Manawatu areas. Meat from the region's four southerly freezing works is shipped by rail primarily to Napier (Port Ahuriri), giving this harbor a volume of meat exports that is considerably inferior to that of Wellington and Auckland, but far exceeds that of other North Island ports.

One of the two leading South Island producers of fattened sheep and cattle is the zone of arable crop and livestock farming on the plains of Canterbury and northern Otago. Railways carry large numbers of animals from farms in this area to the four freezing works near Christchurch, and to the four other plants situated farther south in the region (Fig. 4). In smaller volume, these plants also receive stock from the extensive pastoral farms on the margins of the High Country. The output of the freezing works situated around Christchurch is railed to Lyttelton for export; meat processed in the four works farther south moves by train to Timaru wharves, making these ports inferior

[9] This analysis of meat traffic is based upon statistics for shipments at all freezing works stations, statistics for meat shipments at all ports, field observation, and correspondence with railway officials.

[10] There are six freezing works in Eastland, but the role of railways in servicing the two northernmost plants, Tokomaru Bay and Gisborne, is small. The Tokomaru Bay works is 58 miles beyond the end-of-track at Gisborne, and makes no use of rail service; the waterside Gisborne works receives some animals by rail, but sends its frozen meat to exporting harbors by coastwise shipping. (See Fig. 3.)

only to Bluff among South Island meat exporting harbors.

The arable crop and livestock farms southwest of Dunedin are the other major source of meat animals on the South Island. However, the situation of five freezing works within the narrow zone of maximum productivity in this region, and the consequent proximity of a large part of the region's livestock population to these processing plants causes short-haul road carriers to play a larger-than-usual role in the livestock receipts of southern Otago and, more particularly, Southland freezing works. Consequently, rail movements to freezing plants are less than the livestock productivity of these districts might suggest. Comparatively small numbers of fattened and surplus animals are also shipped by rail to coastal works from the extensive sheep stations and scattered arable crop livestock farms in interior Otago and interior Southland. Meat from the three Southland freezing works is shipped to ships at Bluff, making it the leading South Island meat shipping port. The output of the two works in southern Otago moves by train to the Otago Harbour ports.[11]

The small plains in the other regions of the South Island—Westland, Nelson, and Marlborough—make a much less significant contribution to New Zealand meat production. Westland's fattened stock, largely cattle, travel across the Southern Alps to Christchurch slaughterhouses. The fat lambs and surplus cattle of Marlborough and Nelson move mainly to small local freezing works. Some of these animals are shipped by rail, but trucks play major roles here because of the incomplete coverage of productive areas by railways and the prevalence of short hauls between freezing works and farms on the small productive plains.[12] Neither of the freezing works in these regions ships meat by rail; in Nelson, trucks link the plant with the docks, and the waterside plant at Picton, in Marlborough, loads its output directly onto ships.

Dairy Products Moving from Farm to Factory, thence to Market

As was mentioned above, most of New Zealand's milk and cream is processed into butter, cheese, and other dairy products at factories which are scattered over the dairy farming districts of the dominion. The markets for these products are largely overseas, and in consequence there is a considerable rail traffic in dairy manufactures between factories and ports.[13]

The vast production of dairy factories in Northland and South Auckland is shipped by rail to the wharves of Auckland, making this harbor far and away New Zealand's leading exporter of dairy products. From the intensive pastoral farming districts of western Taranaki, dairy manufactures are sent primarily to New Plymouth, the dominion's third ranking dairy exporter, for loading onto ships. To the docks of Wellington comes the output not only of dairy factories in the Manawatu area, but also that of the scattered plants of Eastland, giving this port marked superiority to New Plymouth in the export of dairy products.

On the South Island, the very small quantity of dairy products exported from factories in Nelson and Marlborough moves out of local ports via coastwise shipping, and rail transportation is little used. A considerable part

[11] The Otago Harbour ports are Dunedin and Port Chalmers.

[12] The entire Nelson railway (60 miles) was abandoned and dismantling begun on September 3, 1955.

[13] This analysis of dairy products traffic is based upon dairy factory production statistics, statistics for dairy products shipments from ports, field observations, and interviews.

of the output of dairy plants in Marlborough, Westland, and Canterbury is consumed on the South Island itself, and part of the small surplus left for export moves by rail to Lyttelton and Timaru for loading onto ships. The meager output of the handful of dairy factories in Otago reaches the wharves of Dunedin and Port Chalmers by train, whereas the much larger production of Southland's plants is railed to Bluff, making it the only South Island harbor that handles a significant dairy export traffic.

Wool Moving from Farm to Market

From the sheep rearing areas of New Zealand, and thus from virtually all of the country's agricultural lands, is shipped a large and valuable tonnage of wool.[14] As we have already seen, wool is the major product of operations on the sheep stations of the South Island High Country, but as farming becomes more intensive, wool, though still important, is reduced to the rank of a by-product.

The wool production of southwestern and adjacent interior sections of the North Island is concentrated on Wellington, and gives this harbor first rank among the dominion's wool exporters. Wool from Eastland's sheep flock moves by rail to Napier (Port Ahuriri) for export, making this one of New Zealand's three leading wool shipping ports. Similarly, the clip from the sheep flocks in northern sections of the island is railed to Auckland, and a wool tonnage sufficient to place this port among the first three in the country is loaded onto overseas vessels at its wharves.

From sheep farms in northern portions of the South Island, small quantities of wool move, largely by road, but partly by rail, to Picton, Nelson, and smaller ports for shipment. The much larger wool clip of Canterbury and the adjacent High Country reaches overseas vessels primarily at Lyttelton (the South Island's first ranking wool exporter), but also at Timaru. Wool from Otago, Southland, and the parts of the High Country which lie interiorward of these areas is shipped by rail in considerable volume to Otago Harbour ports, and also to Bluff.

Wheat Moving from Farm to Mill and thence to Market

New Zealand's farms normally produce less than half the dominion's wheat requirements, and the deficit is usually made up by imports from Australia. Because most of the wheat crop is grown by arable crop and livestock farms on the plains of Canterbury and northern Otago, New Zealand Railways' wheat traffic is primarily a feature of the South Island system.[15] From railway depots serving Canterbury and Otago farms, some grain moves to local mills for conversion to flour, but larger quantities are shipped by rail to plants in the major urban places—particularly in Christchurch, and to a lesser degree in Timaru and Dunedin. The mills of Canterbury and northern Otago process about two-thirds of all wheat milled in New Zealand; their flour is distributed to all parts of the South Island, and to the North Island.

Because it is based upon South Island and imported Australian wheat, North Island grain traffic moves in a pattern fundamentally different from that on the South Island. Wheat is unloaded from ships at major ports, most con-

[14] This analysis of wool traffic is based on statistics covering the distribution of sheep shorn, statistics for wool shipments from ports, field observation, and correspondence with railway officials.

[15] This analysis of wheat traffic is based upon wheat acreage statistics, data on the distribution and production of flour mills, field observation, and interviews.

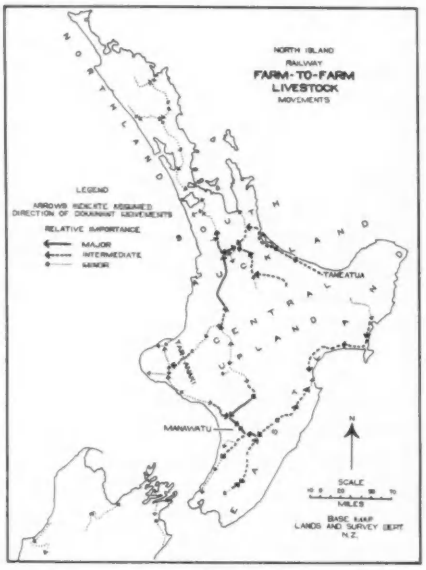

FIG. 5

spicuously in Auckland where it is milled in large quantities for consumption in northern districts of the island. The other major North Island milling centers, in the Manawatu area, receive most of their grain from ships that dock at Wellington, and ship by rail to southern parts of this Island the flour that they mill.

It is evident that flour traffic on the railways of the South Island, and both wheat and flour movements on the North Island lines, are reciprocal to the dominant farm-to-market rail traffic flows.

FARM-TO-FARM MOVEMENTS

On the New Zealand Railways, farm-to-farm movements are dominated by traffic in store stock.[16] The railways also carry quantities of feeds and fodder crops, but because the dominion's agriculture is based primarily upon pastoral farming, this traffic is not of fundamental importance. Store stock traffic almost always flows from extensively farmed areas to districts devoted to more intensive forms of agriculture, and, throughout New Zealand, rugged extensive grazing lands act as vast livestock reservoirs for the intensively farmed plains.

On the North Island railways, the outstanding store stock movement carries large numbers of cattle and sheep to intensive pastoral farms on the plains of South Auckland (Fig. 5). These animals come from sheep stations on the northern margins of the Central Upland, and from other extensive pastoral farms in the hill country districts that border the plains. This livestock supply is augmented by cattle and sheep from Eastland which travel overland to the Taneatua railhead, there to be shipped to depots on the plains of South Auckland. The rugged extensive pastoral lands of Eastland also supply large numbers of breeding, replacement, and fattening animals to intensively farmed districts on the scattered plains of this region, and on the Manawatu Plain to the west. Larger quantities of store stock come to the intensive pastoral farms on the coastal lowlands of Manawatu and adjacent Taranaki from inland Taranaki and from southern portions of the Central Upland. Store stock are also loaded at railway depots in Northland—primarily for shipment to intensively farmed areas within this region, but some of these animals are hauled to farms south of Auckland.

Store stock movements on the South Island have an analagous pattern (Fig. 6). Fattening, breeding, and replacement animals from extensive sheep stations on the margins of the High Country in Marlborough and western Canterbury and Otago are shipped by rail to depots

[16] In New Zealand, the term "store stock" is used to refer to cattle or sheep that are reared, usually on extensive pastoral farms, to be sold in more intensively farmed areas as replacement, breeding, and fattening stock.

serving the arable crop and livestock farms on the plains of Canterbury and northern Otago. The intensively farmed plains in the coastal zone southwest of Dunedin receive store stock from extensive grazing areas tributary to the railways that penetrate the interior of Otago and Southland. Local store stock movements in Nelson, Marlborough, and Westland, handled partly by road and partly by rail, supply store stock to the small areas within these regions that are devoted to intensive farming.

FIG. 6.

MOVEMENTS FROM CENTERS OF MANUFACTURING AND EXTRACTIVE ACTIVITY TO FARMS

The third major type of railway traffic movement that is related to New Zealand agriculture is the flow to farm consumers of products from manufacturing and extractive industries. Because New Zealand's major exporting ports are also its principal receivers of goods from overseas, and the primary centers of domestic manufacturing, traffic in manufactured goods shipped to farms is largely reciprocal to the farm-to-market movements discussed earlier. The pattern of traffic from extractive industries to farms is, of course, largely determined by the distribution of resources, or rather, the places where extraction takes place. However, on a large part of the railnet, this movement, too, is reciprocal to the farm-to-market traffic flow.

Products of Extractive Industries Moving to Farms

The extractive industry products that are carried to New Zealand farms in significant amounts are fuels, timber, and agricultural lime. Small quantities of coal are used for domestic heating on the dominion's farms, but most heat is provided by locally cut firewood, or by electric heaters. Petroleum products, almost entirely imported, provide fuel for farm tractors, trucks, and automobiles. Because its sources are overseas, petroleum is shipped by rail into rural areas from New Zealand's major ports.

Small quantities of timber are used on New Zealand farms for construction and fencing. Timber traffic originates at railway stations in the major extracting areas of the central part of the North Island, and in western and southern portions of the South Island, and moves over main and branch lines to reach farming districts.[17] Receipts of timber for farm use are greatest in farm areas lacking adequate local lumber supplies—particularly in eastern parts of the South Island, and on large plains everywhere in the dominion.

More important, however, than any of these traffic flows, is the large tonnage

[17] This analysis of timber traffic is based on statistics for inward and outward traffic at each officered railway station, field observation, and conversation and correspondence with railway officials.

of agricultural lime that the railways carry to New Zealand's farmlands.

Agricultural Lime Moving from Lime Works to Farms[18]

The livestock farming that is the dominant feature of New Zealand agriculture is based primarily upon grazing, and in the dominion, the maintenance of pasture production is very much dependent upon the application of lime and fertilizer, or the practice of "top-dressing." Lime is also essential to successful cropping for either cash or fodder in the arable farming districts of the South Island.

Receipts at railway stations suggest, and correctly so, that agricultural lime is applied in greatest quantities within the cool, humid, coastal districts that lie to the southwest of Dunedin in Otago and Southland (Fig. 7). Although there are major lime works here, the strongly leached soils and the large acreages of fodder crops (Fig. 1) have induced within this area the outstanding lime movement of the entire New Zealand Railways system. Lime comes to these southern districts mainly from the group of large works in northern Otago, and near Winton in Southland.

The other major lime movement on the South Island railway system reveals that large tonnages of this commodity are consumed in the arable crop and livestock farming districts on the plains of Canterbury and northern Otago. Here, the lime-deficient soils, the large acreage devoted to cropping, the necessity for maintaining the productivity of semi-permanent pastures, and the paucity of local lime supplies on the plains have given rise to heavy rail traffic. Principal sources of supply are the groups of lime works on the southern margin of the region, and also the numerous pits of North Canterbury.

Elsewhere on the South Island, lime is used in small quantities and relatively little moves by rail. In interior sections of Southland and Otago, and throughout eastern portions of the High Country, rainfall is light and soils are not strongly lime-deficient; in addition, most of this land can be used only for very extensive grazing that cannot offer economic justification for liming. In Nelson and Marlborough, the small areas of intensively farmed land, and the presence of local supplies preclude a large lime traffic on the railways. Westland's soils are strongly lime-deficient, and its intensively grazed pastures require heavy applications of lime in connection with top-dressing; however, the total lime tonnage moving by train is not large because farming is restricted to small valley flats scattered along the railway lines.

On the North Island, lime is used primarily with chemical fertilizers as a part of the top-dressing that is applied to pastures to stimulate their growth. The relatively high rainfall which is prevalent in most North Island districts causes soils to be leached and deficient in lime, and the intensive pastoral farming of the plains in these areas economically justifies heavy applications of lime. The pattern of North Island railway traffic would suggest that liming was most intensive on the plains of South Auckland, and, secondarily, in coastal districts stretching westward from Manawatu into Taranaki (Fig. 7). Actually, however, the greatest intensity of lime application on the North Island occurs in the warm, humid districts of Northland where intensively farmed land is limited to small, scattered plains. In this region, lime pits are practically ubiqui-

[18] This analysis of lime traffic is based on statistics for inward and outward traffic at each officered railway station, field observation, and conversation and correspondence with railway traffic officials.

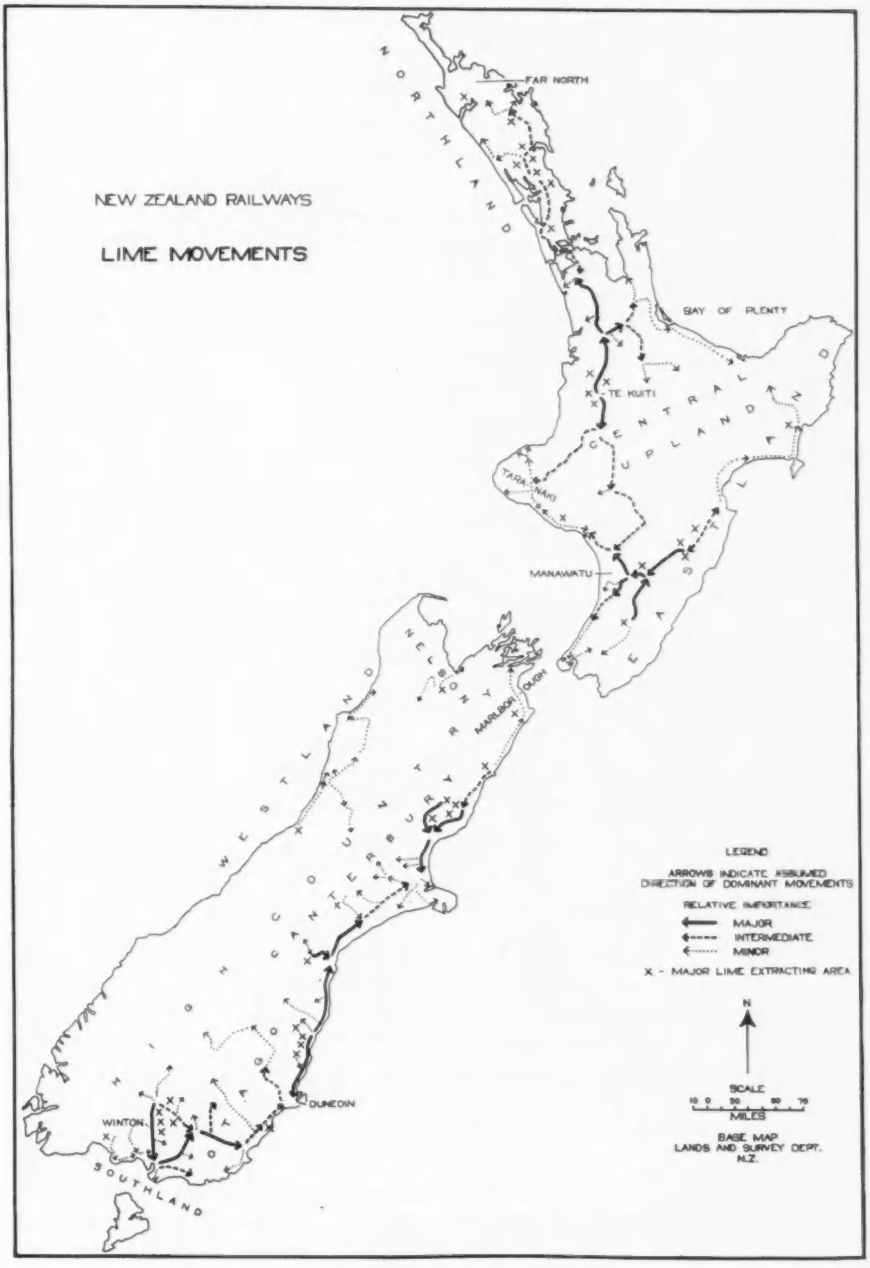
NEW ZEALAND RAILWAYS
LIME MOVEMENTS
FAR NORTH
NORTHLAND
BAY OF PLENTY
TE KUITI
TARANAKI
MANAWATU
MARLBOR
OUGH
WESTLAND
CANTERBURY
DUNEDIN
WINTON
SOUTHLAND
LEGEND
ARROWS INDICATE ASSUMED DIRECTION OF DOMINANT MOVEMENTS
RELATIVE IMPORTANCE
MAJOR
INTERMEDIATE
MINOR
X - MAJOR LIME EXTRACTING AREA
N
SCALE
10 0 30 60 70
MILES
BASE MAP
LANDS AND SURVEY DEPT.
N.Z.

FIG. 7.

tous, and the widespread availability of this substance has both encouraged its use and reduced the need for long-distance rail transportation. As a result, railway lime traffic does not adequately reflect the large lime consumption in this part of New Zealand. The railheads for the lime-poor Far North, however, do receive considerable tonnages from central Northland and pits farther to the south.

North Island railway lime traffic is heaviest on the lines which carry this commodity into the intensive pastoral farming districts on the plains of South Auckland, from works near Te Kuiti, and, in lesser volume, from pits in Northland. The intensively grazed lands along the coast between Manawatu and Taranaki[19] receive large quantities of lime by train from the central section of Eastland, and smaller amounts from the Te Kuiti area, and from pits within the region.

In Eastland, plains devoted to intensive pastoral farming are small and scattered, and, more important, lime works are well dispersed among the farming districts; consequently, the need for rail haulage is reduced and traffic to depots in Eastland is not heavy even though a considerable quantity of lime is used in this area. Very little lime is railed to depots along the shores of the Bay of Plenty and to stations that serve the Central Upland, for the soils of these areas have developed from "recent" volcanic materials and do not respond favorably to liming. Furthermore, in most interior sections of the North Island, agricultural activity is limited to extensive grazing which does not yield sufficiently large returns per acre to make heavy applications of lime economic.

[19] Since the period covered by this study, lime usage has declined greatly in western Taranaki because the Department of Agriculture recently discovered that the volcanic soils of that area do not respond to liming.

Movements of Manufactured Goods from Factory to Farm

In New Zealand, the major sources of all types of manufactured goods are the four main centers: Auckland, Wellington, Christchurch, and Dunedin. As we have seen, this is the result of the leadership of these places as importing ports and as centers of manufacturing. From the four urban areas, each of which is the focus of a major part of the railnet, flow large tonnages of implements, processed foods, and other consumer goods which are distributed in rural districts that are penetrated by the railnet. However, the type of manufactured goods traffic that is of greatest significance to agriculture is the movement of large tonnages of fertilizer from factories to farming areas in all parts of New Zealand.

Fertilizer Moving from Factory to Farm

Another important facet of New Zealand land management is the application of fertilizers,[20] primarily superphosphate, to pastures as a means of stimulating the growth of the clovers in the sward. Fertilizers are spread, or top-dressed, onto the land either by themselves or, less commonly, accompanied by lime. The widespread application of various types of fertilizers as top-dressing has produced a very large rail traffic in this commodity.[21]

The pattern of traffic in manufactured fertilizer on the railways is compara-

[20] The term fertilizer is here used to include superphosphate, basic slag, other phosphates, blood and bone, potash, sulphate of ammonia, and nitrate of soda. Animal manures and lime are specifically excluded from this term.

[21] This analysis of fertilizer traffic is based on statistics for inward and outward traffic at each officered railway station, field observation, and conversation and correspondence with railway officials.

tively simple. Farms are supplied primarily from eight large fertilizer manufacturing plants[22] which are located at focal points in the railnet (Fig. 8). Some fertilizer works receive most of their phosphate rock and chemicals by truck from near-by wharves, but plants that are more remote from overseas ports get their supplies by rail. In addition, on each island there are railway movements of serpentine rock, which is another important raw material used in fertilizer manufacture. North Island serpentine is quarried at Pio Pio in South Auckland, and a large tonnage is shipped to fertilizer plants by train from near-by Te Kuiti; on the South Island, serpentine is quarried at Mossburn in Southland, and moves by rail to the fertilizer works (Fig. 8). Additional small quantities of fertilizer, mainly basic slag and phosphate rock, are unloaded at various important ports and are railed directly to farm consumers.

Much of the fertilizer used in New Zealand is applied to permanent pastures in the intensive pastoral farming districts on the North Island. Additional large quantities are used on the more extensive pastoral farms which occupy the hill and mountain districts of this island.

As the pattern of railway traffic clearly indicates, fertilizers are applied in largest quantities, and with greatest intensity, to the intensive pastoral farming districts on the plains of South Auckland (Fig. 8). The three large fertilizer works on the southern outskirts of Auckland, and, to a much smaller extent, ships that dock at Auckland wharves, supply these areas. These same sources, supplemented by ships unloading at Whangarei, also ship considerable tonnages of fertilizer by rail to the intensive grassland farms on the small, scattered flats of Northland, and to the much larger areas of extensive hill country grazing lands of this region.

The Eastland area is a major fertilizer consumer, but has no manufacturing plant[23] within its limits, and the resulting fertilizer movement is composed of large tonnages moving eastward from other regions. Most important among the sources of this traffic are the two large fertilizer works in the Taranaki-Manawatu area, but the three plants near Auckland also make contributions.

The other North Island area in which pastures are top-dressed with large amounts of fertilizer is, as receipts at railway stations show, the costal zone between Taranaki and Manawatu. The intensive pastoral farms of this section receive fertilizer mainly from the two large superphosphate plants within the region.

We have already seen that the dominant agricultural activity in the interior of the North Island is extensive grazing, and that much of this part of the island is not even occupied by farms (Fig. 2). Consequently, fertilizer receipts at rail depots on the Central Upland and in areas marginal to it are usually small. Exceptional, however, are the large tonnages unloaded at stations serving the northern fringe of this area, for here large quantities of fertilizer are being used in government-sponsored land development projects.

Because intensive pastoral farming is less developed on the South Island, the practice of top-dressing with fertilizer is much less common there than on the North Island, and South Island

[22] Since the period analyzed in this paper, a new fertilizer works has been brought into production at Napier, in Eastland.

[23] As was mentioned above, a fertilizer plant has recently been brought into production at Napier, in Eastland.

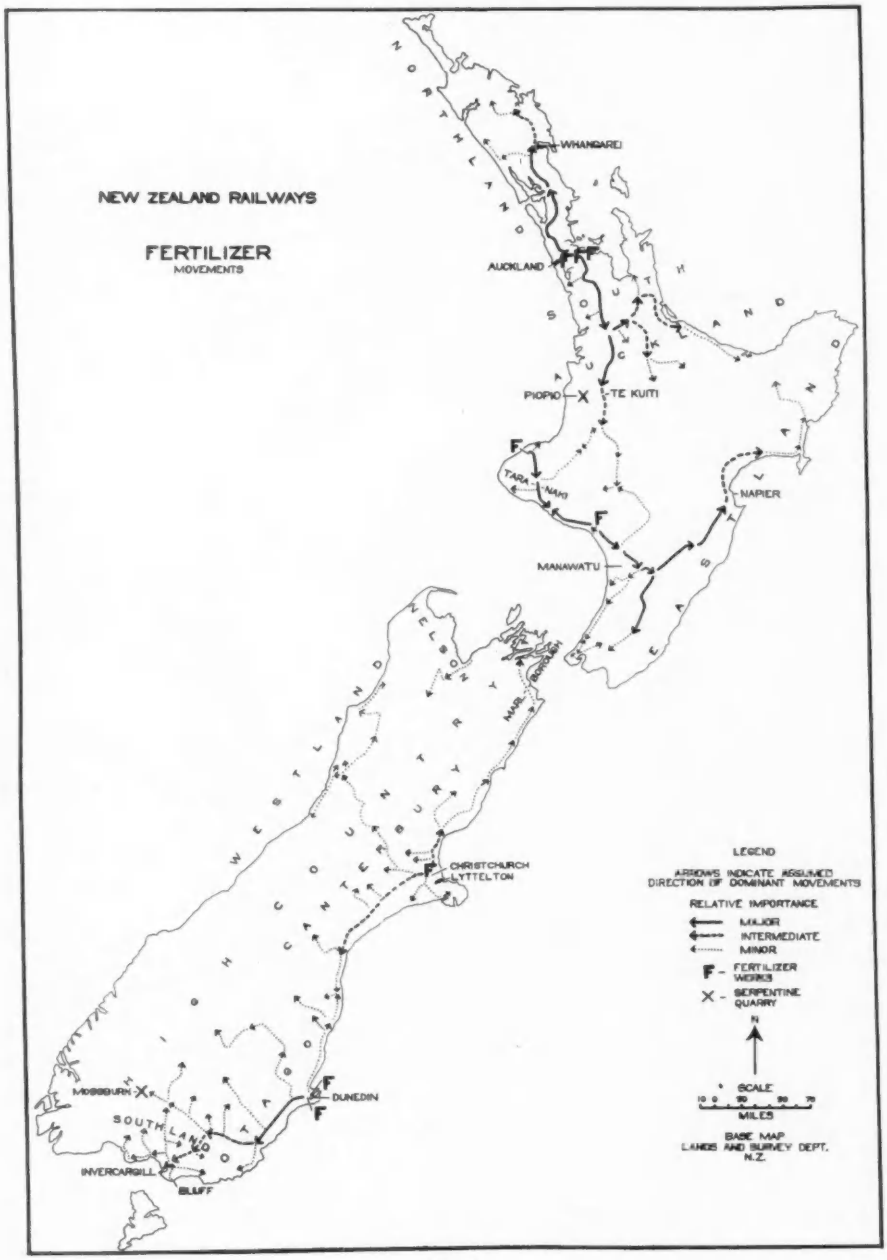
NEW ZEALAND RAILWAYS
FERTILIZER
MOVEMENTS
NORTHLAND
AUCKLAND
WHANGAREI
SOUTH AUCKLAND
PIOPIO
TE KUITI
TARANAKI
NAPIER
HAWKES BAY
MANAWATU
NELSON
MARLBOROUGH
WESTLAND
CANTERBURY
CHRISTCHURCH
LYTTELTON
OTAGO
DUNEDIN
MOSSBURN
SOUTHLAND
INVERCARGILL
BLUFF
LEGEND
ARROWS INDICATE ASSUMED DIRECTION OF DOMINANT MOVEMENTS
RELATIVE IMPORTANCE
MAJOR
INTERMEDIATE
MINOR
F - FERTILIZER WORKS
X - SERPENTINE QUARRY
N
SCALE
MILES
BASE MAP
LANDS AND SURVEY DEPT. N.Z.

FIG. 8.

railway fertilizer traffic amounts to less than one-third the volume moving on the North Island Lines. However, top-dressing that is intensive by South Island standards occurs in the humid, coastal areas southwest of Dunedin which are devoted to dairy and fat-lamb farming, and contain large acreages of semi-permanent pastures (Fig. 1). The two fertilizer plants that are the primary suppliers of this demand are located close to Dunedin, and they ship large tonnages (for the South Island) to points on the plains of southern Otago and Southland (Fig. 8). These areas also receive small quantities of fertilizer that are railed directly from ships docking at Bluff, or from redistributors in Invercargill.

The other major South Island fertilizer consuming area is on the plains of Canterbury and northern Otago; top-dressing is applied to rotation pastures which are an important part of the system of arable crop and livestock farming that is the dominant agricultural activity in this area. Most of the fertilizer carried by train to the farms of this area is shipped from the fertilizer works near Christchurch, but some slag and phosphate rock are also shipped by rail directly from the docks at Lyttelton to rural districts.

Elsewhere on the South Island, the quantities of manufactured fertilizer used are small indeed. The natural-pasture grazing of the High Country is too extensive to warrant heavy top-dressing. In Westland, Nelson, and Marlborough, the areas of intensively grazed land are so small that the quantities of fertilizer required do not give rise to a substantial rail traffic.

CONCLUSION

New Zealand railway traffic that is related to agriculture can be categorized into three basic types of movements: (1) farm-to-market, (2) farm-to-farm, (3) manufacturing or extracting center-to-farm. It is reasonable to expect that agricultural traffic on the roads or railways of other areas would also be composed of these three fundamental movements. Thus, farm-to-market traffic, which on the New Zealand Railways is composed largely of livestock and frozen meat, has its American counterpart in the heavy stock and meat traffic moving out of the Midwest. American farm-to-market traffic, of course, is also made up of great volumes of grain, fruits, vegetables, and industrial crops, which generally move toward the northeastern part of the country. On the railways of Nigeria, farm-to-market traffic is dominated by vast tonnages of groundnuts (peanuts) moving to the exporting ports, while in Malaya it is rubber en route to wharves that is the most conspicuous feature of this movement. Farm-to-market traffic on the Burma Railways is exemplified by rice moving from "up-country" stations to harbors with overseas connections.

New Zealand's farm-to-farm store stock movements are duplicated in the United States by the well-known shipments of "feeder" cattle from western ranges to Corn Belt farms, and by the large quantities of feeds that are hauled from grain-surplus regions in the West and Midwest to more intensively farmed, feed-deficit areas in the Northeast.

Traffic composed of agricultural and domestic supplies moving from manufacturing and extractive centers to farms, which is essentially reciprocal to the farm-to-market movements, will be a feature of all commercial farming regions, and would consist of types of goods generally similar to those moving over the New Zealand Railways. It is logical to expect that the proportion of this traffic composed of fuels, machin-

ery, and consumer goods would be larger in areas with relatively high standards of living. Moreover, "imports" of foods might be a significant feature of traffic flowing into the most highly specialized agricultural areas. Thus, the American Corn Belt receives machinery of all types, and clothing and other consumer goods from the Manufacturing Belt of the Northeast, petroleum products from the Southwest, coal from areas to the south and east, and fruits and vegetables from specialized horticultural districts in the Far West and the South.

The three basic types of agricultural traffic flows which have been enumerated appear to provide useful organizing concepts for the study of farm commodity movements in diverse parts of the world. Further investigation in other areas may reveal that consideration of additional basic movements, not here recognized, will be necessary, and it is hoped that the ideas presented in this paper will stimulate such work.

BOOK REVIEWS

Free Ports and Foreign-Trade Zones, by RICHARD S. THOMAN. xii and 203 pp.; maps, diagrs., ills., bibliogr., index. Cornell Maritime Press, Cambridge, Md., 1956. $7.00. 9¼ x 6 inches.

Professor Thoman has written a very useful book. Although literature is abundant on the subject, there are but few comprehensive studies such as this one.

The book is divided broadly into three parts. Chapter one corresponds to part one and deals with definition, distribution, and historical development of free ports. Part two groups several chapters devoted to specific studies of free ports and foreign trade zones: (1) the free ports of the German Federal Republic, (2) the free ports of Scandinavia, (3) the North European free ports and alternative systems, and (4) the foreign-trade zones of the United States. Part three is a succinct review of the question "designed for the reader whose time is limited."

In fact, the author's survey of foreign-trade zones and free ports abroad is a search for methods, organizations, and systems that could be applied successfully in the United States. The reviewer agrees with him when he states "that the foreign-trade zone movement in the United States has met with moderate, but not overwhelming success." The reviewer is rather of the opinion that it has been a failure. Of the seven zones created in the United States, two are closed (Mobile, Ala., and San Antonio, Tex.); three show annual deficits (San Francisco, Los Angeles, and Seattle); and two (New York and New Orleans) report small financial profits. Is it worth while continuing the experiment? As long as it proves a sound financial proposition, why not? The foreign-trade zones of the United States differ in name only from the North European free ports. They have the same legal foundation, same form of organization (a plot of ground under political authority of the host nation, separated from customs territory by fences, and guarded by customs officials), and the same functions (merchandise stored, exchanged, manipulated, exhibited, or manufactured and re-exported).

The author has classified the free ports of the world in two categories: free ports of outlying areas such as Hong Kong, Singapore, Colon, or the free zone of Trieste, and free ports of highly industrialized, tariff-enclosed nations such as the ports described in part two, namely: Hamburg, Copenhagen, Stockholm, and Rotterdam. To be successful, free ports must be established "As large, dynamic units in equally large, dynamic seaports." This is the story of Hamburg and Bremen. But, as the author points out, bonded warehouse systems appear to be also successful in large and dynamic seaports and equally successful in smaller places.

Would it not be preferable for the United States to reappraise the bonded warehouse system, improve it, and repeal the foreign-trade zones legislation? It would appear to be the logical step.

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Pioneer Peasant Colonization in Ceylon: A Study in Asian Agrarian Problems, by B. H. FARMER. 387 pp.; maps, ills., index. Oxford University Press, London (issued under the auspices of the Royal Institute of International Affairs), 1957. $8.80. 8½ x 5½ inches.

Peasant land colonization in the tropics has been a continuing object of interest to the world for many decades, and has been mooted by many as man's salvation in his struggle against hunger and under-employment in an expanding world population. However, far too little geographic study and writing has been done on the subject of tropical colonization, regarding its past accomplishments and future prospects for the world. To this end B. H. Farmer has turned his efforts and attention over the past few years to a serious attempt to "take the measure" of pioneer peasant colonization in one small section of South Asia—Ceylon—in a study which is representative of the broad Asian Agrarian Problems complex.

Farmer has studied the Dry Zone colonization portions of Ceylon carefully and methodically, critically and thoughtfully. He has delved deeply into the nation's governmental records, both British colonial and current independent, to view understandingly official aspirations against accomplishments, and man against himself. He has traveled widely within neighboring South Asian countries where similar agrarian problems and population pressures exist, thus being able repeatedly in his book to compare and contrast conditions and developments in Ceylon with developments in countries even as far afield as Egypt and the Philippines.

Farmer has been by no means a mere descriptive reporter in this book, still less has he allowed himself at any time apparently to be an uncritical advertiser of any established policy or system. He has studied the subject of peasant colonization deeply, and written objectively, with no axe to grind and no favor to curry. He has put his profusely documental findings and conclusions into intelligent and informal lan-

guage, and given his book appeal to those concerned specifically with colonization and settlement in Asia, and also to that still wider circle who feel a real concern today over the general problems of "living standards" in the Asiatic world's "underdeveloped" countries, as well as the impact of Western ideas, capital, and technology on the whole Eastern world's society and future.

Part I of this book sketches briefly Ceylon's Dry Zone, where peasant colonization is being stressed, as a region steeped in ancient glory and current difficulty, and then attempts to analyze the whole country's physical, social, and economic character. Part II traces historically the establishment and evolution of the government's policy for peasant colonization development in Ceylon. Part III, the longest and most penetratingly written, is first concerned with a host of interacting forces and situations responsible for many grave problems now facing the government of Ceylon as it tries to carry out its tasks, then follows with a realistic assessment of peasant colonization contributions to the nation's pressing "food and population" problem, and concludes with suggestions for future official and private action and research in the country, which might well be appropriate beyond as well as within the confines of Ceylon's national borders. This arrangement of materials is very successful in giving understanding and substance to what by another organization might have become a tedious enumeration of facts and personal observations.

The chief interacting forces and situations mentioned above, and held by the author as responsible for many grave problems facing the government of Ceylon today, may be summarized briefly in the order in which the author presents and discusses them within Part III. (1) The *physical planning* of colonies presents many problems because insufficient attention has been given regarding local variations and physical conditions. Standardization has gone too far in recent years. (2) *Irrigation planning* difficulties have arisen due to such causes as insufficient flood data, piecemeal restoration, siltation, etc. (3) *Colonist selection* has been a great stumbling block as viewed from the standpoint of human character and ability, as well as the point of selection from within the country to give greatest relief to population pressure areas. (4) *Disease and Malnutrition* have been and still are great bogies to the colonization planners. (5) *Domestic water supply* creates health as well as other social problems and its siting needs be based on sounder principles. (6) The seemingly simple factor of *Land Use* is also a persistent problem, especially where a change is attempted with the cultivator's past experiences. (7) The *economy of the colonist* involves primarily his "needs" as defined by an ideal "economic holding." (8) The *social factor* is involved and complex because most colonization schemes have been imposed without sufficient regard for the attitudes, values, and social notions of the colonist's own former village society.

In the author's concluding chapter there is a very interesting treatment of "possible alternatives to peasant colonization as it is at present understood in Ceylon." These alternatives take the form of (1) complete government abandonment of colonization sponsorship, (2) substitution of "village expansion" in lieu of "colonization," (3) capitalist, collective, and cooperative farming, or (4) an eclectic solution, in which several different methods of agricultural development might be tried concurrently.

The author, Mr. Farmer, who is a Fellow of St. John's College, Cambridge, and a University Lecturer in Geography, undertook the basic field investigation on which this book is based in 1951, and was in 1955 appointed by the Ceylon Government to a Commission which was charged with reviewing the country's entire land policy. He has thus become through the years, so intimately acquainted with pioneer land colonization in Ceylon, both theoretical and actual, as well as acquainted in the whole south Asian world, that he almost completely avoids the small but sometimes very irritating assumptions and statements that the foreigner from the West is so likely to commit in a book of this kind: those few committed are not considered worthy of mention, even by a reviewer who has lived long in the East and acquired some of the Easterner's sensitiveness to the ways and words of the West.

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Problemas Económicos y Sociales de los Andes Venezolanos, Parte II. 136 pp.; maps (some in color), diagrs., ills., tables. Consejo de Bienestar Rural, Apartado 2797, Caracas, Venezuela, 1957. 12½ x 9 inches.

Part II of the study of economic and social problems in the Venezuelan Andes gives a bird's-eye view of the entire Andean cultural area of the country. (For review of Part I see *Econ. Geog.*, Vol. 32, 1956, pp. 373–374.) Intensive studies of the various aspects of the nuclear family—composition, domestic relations, and religious customs, diet, health, and aspirations among others—reveal an economic dualism disruptive of the old order. Andinos are acquiring modern, urban tastes and desires at a rate much greater than their ability to satisfy them economically. Farmers are limited in their capacity to produce money crops by cultural factors such as the dominant systems of landholding and of farming techniques. Their situation is made more acute and precarious in many sectors by physical factors such as poor

soil, steep slopes, and so on. As the gulf widens between aspirations and actual production, the agricultural economy of the Andes is thrown out of balance and the individual becomes a prey to frustrations.

This state of affairs leads to migration. Young women seek employment as domestic servants in the nearby Andean towns or cities, while the young men go farther away, to a big city such as Maracaibo. But the young man skilled only in the use of the machete or other crude farm implement is not capable of rapid adjustment to urban life. Hence many young men, sometimes whole families, are migrating to other rural areas in the country, especially to the *tierra caliente*, where land is relatively cheap and is available in large or small plots, and where a clear title to it can be obtained. Such land is to be found in the lower foothills of the Cordillera and in the piedmont alluvial plains bordering the Cordillera. (For a discussion in English of various phases of the phenomenon of Andean migration, *cf.* R. E. Crist, "Along the Llanos-Andes Border in Venezuela: Then and Now," in *Geogr. Rev.*, Vol. 46, 1956, pp. 187–208, ref. pp. 199–201.)

Society in the Venezuelan Andes has not been static. Over the centuries since the Conquest gradual changes have been experienced, as shown in Chapter V. In recent years, however, the tempo of change has increased markedly, largely as a result of the revolution in the transportation system. Coactive at the same time have been such highly significant factors as the presence of available virgin land and the vigorous public health campaign, particularly the anti-malarial phase of that campaign. Thus the horizon of the Andino—imbued with what Alfred North Whitehead might have called dynamic thought—is broadening, is opening out, as he enters the *tierra caliente*, the tropical lowlands, the last great frontier zone of settlement in the world.

The authors warn against unlimited faith in the machine, which often results in needless mechanization imposed by over-specialized technicians who are working from a blueprint drawn up too far from the base of operations. The migrant Andinos are land hungry; they know that land produces food, to eat or to sell. So they want land. Mechanization may function where land is farmed in large units, but not under conditions implicit in settlement by small peasants with little or no capital, who have only fire and the machete for clearing the forest. A tractor, even if given free of charge to such settlers, is more apt to be an economic burden than an asset.

This volume—based exclusively on field work—is a great credit to the *Consejo de Bienestar Rural*, which entity has as its general objectives the increase of agricultural production and the improvement of living conditions in rural areas. Questionnaires were used, but they are not considered an end in themselves. Personal interviews and common sense have given color and meaning to analyses based on the information collected from questionnaires. Students who acquired the techniques of field investigations while working on this volume will most certainly continue to make significant contributions in Venezuela to the literature on agricultural economics, rural sociology, social anthropology, and human geography. The work is profusely illustrated with superb photos, well selected, effective, and artistic.

Professor Henry S. Sterling, in charge of the project, is to be congratulated for having so happily co-ordinated the studies of a team of six distinguished social scientists; he gives much credit to Professor Lorenzo Monroy for his outstanding work in the field.

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The Dark Missouri, by HENRY C. HART. xv and 260 pp.; maps, ills., tables, index, bibliogr. The University of Wisconsin Press, Madison, 1957. $6.00. 9¼ x 6 inches.

This is an informative book. The range of facts is wide and the interpretations generally make sense. At the same time, there is much that is impressionistic—of the nature of a tone poem. Occasionally, perhaps often enough to be disturbing, uncritical statements crop up here and there.

In many ways the book is a contribution to those concerned with the Great Plains and the Missouri Basin. Tracing of the origin of the "desert image," together with plausible explanations for varying accounts of the Great Plains by various explorers; pinning much of the responsibility for the extension of the system of homestead type settlement upon boosters in the region itself; the generalizing that several generations of irrigation farmers fail before they make a go of it; recounting of the relatively long efforts at control of the Missouri River—these points are of interest and, in large part, are not generally known. Not of least importance is an extensive bibliography.

The Dark Missouri does not have a clear focus of interest because of there being two geographical foci—the Missouri River and its basin and the Great Plains. Problems associated with the river and its flood plain and of the Great Plains are dealt with at length, but virtually nothing is said about those considerable parts of Iowa and Missouri included in the basin but above flood waters. Some of the climatic maps fail to include much of either Iowa or Missouri.

Perhaps the topical focus is unclear also. Attention is directed chiefly to water and its uses with particular reference to attempts to

control the uses. The origin of the concept of the Great Plains as desert, for example, is interesting but probably not necessary. Concern with political action and governmental machinery does not become apparent until near the end of the book.

Considerable attention is given problems of Missouri Basin "development," with special note of the Pick-Sloan Plan, approved by Congress in 1944. In what must be considered an effort to be "cute," the combination of the plans of the Corps of Army Engineers (Pick Plan) and the Bureau of Reclamation (Sloan Plan), intended to secure navigation and flood control on the mainstem of the Missouri and of irrigation both in the headwaters and eastward beyond the middle Missouri itself and of hydroelectric power on most major installations, is called a shotgun wedding and results of the program are called legitimate offspring. There are few illusions of easy solutions to the problems dealt with or of the results being other than costly. In fact, one is left wondering if anything besides power development can be generally justified as economically sound. Incidentally, power is expected to pay most of the federal costs of irrigation. Even subsidized heavily, much of the irrigation will be no bargain, even where sufficient care was taken to investigate irrigability prior to construction of facilities. Surprisingly, the problems of domestic and industrial water supply receive no emphasis, although the fact that Wyoming gives priority to industrial uses is included. Although the author does not say so, perhaps the chief uses of water in the Missouri Basin are to be domestic and industrial water supply and power.

Emphasis is given to political problems involved in water development. There are political overtones in the fight between flood protection for the city and the flooding of farms by reservoirs upstream. The conflicts of interests of competing government agencies, of federal and state governments, of state with state, are presented at some length. Interstate agreements on the division of water have been made easier by the fact that "new" water stored by the federal government has not made it necessary to reduce the supply available for either state, it is pointed out. The state, it is argued, should have the responsibility for the operation and reimbursement of publicly financed irrigation.

This reader is not convinced that the following assertions are correct: only the Rockies and Black Hills in the upper basin have dependable run-off (Sand Hills do); extensive filling of canyons by loess took place in years 1539–1564; valley trenching one hundred feet deep has occurred in western Iowa since breaking of the sod; drought reached its peak in 1896; Malin has proved Great Plains Committee wrong in its assertion that erosion in 1934 and 1936 was unequalled in historic time; "it rains seldom here [Great Plains], but hard"; silt in Yellowstone is due to heavy rain (rather than to character of rock); climate demands a grazing unit twenty times the size of the prairie-sized homesteads in the short-grass country; Union Pacific built where the highest level of the plain met the easiest ascent of the Rockies; the reduction of 390,000 in population recommended by Thornthwaite for the Great Plains has been accomplished; one good year in five is enough for the wheat farmer to make a profit; no one questions the desirability of Big Thompson water diversion; Pick-Sloan Plan has vastly increased acreage of stable irrigation water supply.

Perhaps it is unfair to pick details for criticism. In a book like this there are thousands of them. If a vast majority seem plausible and most conclusions seem demonstrated or tenable, the author can hardly be accused of being uncritical even though the material covers the range from physical setting to governmental policy. Dr. Hart is assistant professor of political science at the University of Wisconsin. The amount of material of common interest to political science and geography is impressive.

LESLIE HEWES

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NEW EDITIONS

Chisholm's Handbook of Commercial Geography, by L. DUDLEY STAMP and S. CARTER GILMOUR. Fifth edit. xiii and 915 pp.; maps, diagrs., index. Longmans, Green & Co., Inc., New York, 1956. $16.00. 8½ x 5½ inches.

Cities and Society: The Revised Reader in Urban Sociology, edited by PAUL K. HATT and ALBERT J. REISS, JR. Second edit. 852 pp.; maps, diagrs., ills., bibliogr. The Free Press, Glencoe, Ill., 1957. $7.50. 9½ x 6 inches.

Great Cities of the World, by W. A. ROBSON. Revised edit. 814 pp.; maps, ills., bibliogr., index. The Macmillan Company, New York, 1957. $11.00. 9½ x 6 inches.

Introductory Economic Geography, by LESTER E. KLIMM, OTIS P. STARKEY, JOSEPH A. RUSSELL, and VAN H. ENGLISH. Third edit. x and 730 pp.; maps, diagrs., ills., index. Harcourt, Brace and Company, New York, 1956. $7.50. 9½ x 7 inches.

United States and Canada: A Regional Geography, by ALFRED J. WRIGHT. Second edit. xviii and 590 pp.; maps, diagrs. ills., index. Appleton-Century-Crofts, Inc., New York, 1956. $7.00. 9½ x 6 inches.

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